THE

DISSECTION OF THE HUMAN BODY

HOLDEN

GENERAL TABLE OF CONTENTS.

Price of each volume in uniform binding, $1.50.

HOLDEN'S ANATOMY

A MANUAL OF THE

DISSECTION OF THE HUMAN BODY

EDITED BY

JOHN LANGTON

SURGEON TO, AND LECTURER ON ANATOMY AT, ST. BARTHOLOMEW'S HOSPITAL; MEMBER OF THE BOARD OF EXAMINERS, ROYAL COLLEGE OF SURGEONS OF ENGLAND; SURGEON TO THE CITY OF LONDON TRUSS SOCIETY; CONSULTING SURGEON TO THE CITY OF LONDON LYING-IN HOSPITAL AND TO THE MEMORIAL HOSPITAL AT MILDMAY PARK.

SEVENTH EDITION

REVISED BY

A. HEWSON, M. D.

DEMONSTRATOR OF ANATOMY, JEFFERSON MEDICAL COLLEGE, PHILADELPHIA; SURGEON TO ST. TIMOTHY'S HOSPITAL; DISPENSARY SURGEON, EPISCOPAL HOSPITAL; MEMBER ASSOCIATION OF AMERICAN ANATOMISTS: FELLOW OF THE COLLEGE OF PHYSICIANS, ETC.

IN TWO VOLUMES

VOLUME I.

SCALP, FACE, ORBIT, NECK, THORAX, UPPER EXTREMITY

153 ILLUSTRATIONS

PHILADELPHIA
P. BLAKISTON'S SON & CO.
1012 WALNUT STREET
1901

PREFACE TO THE SEVENTH EDITION

In this edition the editor has carefully revised the entire work, substituted more recent cuts for older ones, and added some additional matter which it is impossible to indicate in the text. The object has been throughout to present the work thoroughly adapted for the use of the students in the dissecting room and for reference by the practitioner. It has been thought well, for the convenience of the former, to divide the book into two volumes. The total number of cuts has not been materially increased, but several new ones have been added from preparations made by the editor.

A. H.

1508 Pine Street, Philadelphia.

PREFACE TO THE SIXTH EDITION.

THE chief feature of Holden's Anatomy that must have become apparent to all who have hitherto used it, is not only that the text has been made so concise, but that the subject is presented in as clear and practical a light as is compatible with the faithful handling of its natural difficulties. It gives to the beginner a proper method of procedure, together with such details as are essential to the thorough understanding of the matter in hand. In making this revision the Editor has worked in accord with the editors of the previous editions, and has made such additions and alterations as seemed necessary to bring the book in line with present knowledge and methods, and has added the Metric Measurements side by side with the English. The entire work has been gone over line for line; specially emphasized points have been added in foot-notes to which the editor has signed his initials (A. H.). There are, however, many additions and alterations in the text that were impossible to thus specify.

It has seemed well, in order to reduce the size of the book and still retain its salient features, to put the more minute and intricate points in a smaller type. This will be found an aid to the student and has allowed of the addition of a large number of new illustrations.

The total number of illustrations has been increased from 208 to 311. This, however, does not show the exact number of new pictures, as many of those that appeared in the old editions have been struck out and replaced by more modern ones, taken chiefly from the works of Sappey, Wilson, and Landois.

A. H.

1508 Pine Street, Philadelphia.

PREFACE TO THE FIRST EDITION.

If any apology be needed for the appearance of the present Manual, it may be stated, without any wish to disparage the labors of others, that the works of this kind hitherto published seem to the Author open to one or the other of two objections; — either as being too systematic, and therefore not adapted for the dissecting-room, or as obscuring the more important features of Anatomy by a multiplicity of minute and variable details.

In endeavoring to supply a presumed deficiency, the Author has made it his special aim to direct the attention of the student to the prominent facts of Anatomy, and to teach him the groundwork of the science; to trace the connection, and to point out the relative situation of parts, without perplexing him with minute descriptions.

A concise and accurate account is given of all the parts of the human body — the bones excepted, of which a competent knowledge is presupposed — and directions are laid down for the best method of dissecting it.

The several regions of the body are treated of in the order considered most suitable for their examination; and the muscles, vessels, nerves, etc., are described as they are successively exposed to view in the process of dissection.

The Author has written the work entirely from actual observations: at the same time no available sources of information have been neglected, the highest authorities, both English and Foreign, have been carefully consulted. His acknowledgments are especially due to F. C. Skey, Esq., F.R.S., Lecturer on Anatomy at St. Bartholomew's Hospital, for many valuable suggestions. He is also much indebted to his young friend, Mr. W. Clubbe, for able assistance in dissections.

September, 1851.

CONTENTS.

LIST OF ILLUSTRATIONS.

A MANUAL

OF THE

DISSECTION OF THE HUMAN BODY.

DISSECTION OF THE SCALP.

Dissection. — An incision should be made from the root of the nose (*nasion*) along the mesial line of the vertex to the external protuberance of the occipital bone (*inion*); another horizontally round each half of the head, to join at right angles the two ends of the first incision. These incisions must not divide more than the skin, so that the subcutaneous vessels and nerves be not injured. It is well to dissect on one side of the head the muscles only, reserving the other side for the dissection of the vessels and nerves.

Strata Composing the Scalp. — The several strata of tissues covering the skull-cap are — 1, the *skin;* 2, a thin layer of *connective tissue* and *fat* which contains the cutaneous vessels and nerves and the bulbs of the hair; and by which the skin is very closely connected to, 3, the *broad thin aponeurosis* of the occipito-fontalis muscle (aponeurosis of the scalp); 4, an abundance of loose *connective tissue*, which permits the free motion of the scalp upon, 5, the *pericranium*, or periosteum of the skull-cap.

Immediately beneath the skin, we expose the thin stratum of connective and adipose tissue which firmly connects it with the aponeurosis of the scalp. This layer is continuous behind with the superficial fascia covering the muscles at the back of the neck, and laterally it passes over the temporal fascia. It forms a bed for the bulbs of the hair and for the ramifications of the cutaneous arteries. The toughness of this tissue, in which the arteries ramify, does not permit them to retract when divided; hence the hæmorrhage which follows incised wounds of the

scalp; hence also the difficulty of drawing them out with the forceps.

Occipito-frontalis Muscle and Epicranial Aponeurosis. — This cutaneous muscle is closely connected to the scalp. It consists of two fleshy portions, one on the occiput, the other on the forehead, connected by a broad aponeurosis. The *occipital portion* of the muscle is thin, and takes origin from the outer two-thirds of the upper curved line of the occipital bone, and the adjoining part of the mastoid process of the temporal bone. The

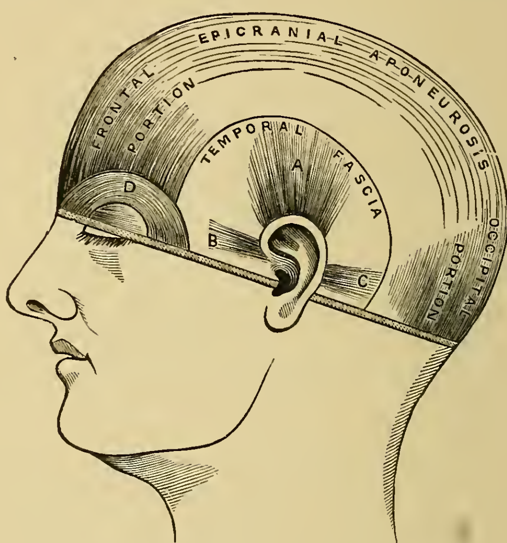


FIG. I.—DIAGRAM SHOWING THE MUSCULAR AND APONEUROTIC STRATUM OF THE SCALP.
A. Attollens aurem. B. Attrahens aurem. C. Retrahens aurem. D. Orbicularis palpebrarum.

fibres ascend over the back of the head for about two inches, and then terminate in the epicranial aponeurosis. The *frontal portion,* commencing in an arched form from the epicranial aponeurosis below the coronal suture, descends over the forehead, and terminates partly in the skin of the brow, partly in the orbicularis oculi and corrugator and supercilii, while some of the inner fibres are continuous in front of the nose with the pyramidalis nasi muscle. The aponeurosis of the scalp covers the vertex of the skull, the two being continuous across the middle line. It is continued over the temples and side of the head,

gradually changing from tendinous into connective tissue. This muscle enables us to move the scalp backwards and forwards. But its chief action is as a muscle of expression. It elevates the brows, and occasions the transverse wrinkles in the expression of surprise.

The occipital portion is supplied by the posterior auricular branch of the facial; the frontal portion by the temporal branch of the same nerve.

Muscles of the Ear. — There are several small muscles to move the cartilage of the ear. In man they are thin and pale, and require care to dissect them out satisfactorily. In animals, who possess a more delicate sense of hearing, they are much more developed, for the purpose of quickly directing the cartilage of the ear towards the direction of the sound.

Attollens Aurem. — To indicate the position of this muscle the student should draw down the upper part of the pinna of the ear, when it will be found immediately under the ridge of skin so produced. It is a thin, fan-shaped muscle and *arises* from the epicranial aponeurosis, and is *inserted* into the cranial aspect of the upper part of the concha.

Attrahens Aurem. — This muscle is the smallest of these muscles, and its situation is indicated by the prominence of skin produced by drawing backwards the front part of the helix, or outer rim of the cartilage of the ear. It *arises* from the aponeurosis of the occipito-frontalis, and is *inserted* into the front of the helix.

Retrahens Aurem. — This muscle is exposed by reflecting the skin from the ridge produced by drawing the pinna forwards. Consisting of two or three fasciculi, it *arises* from the base of the mastoid process and is *inserted* into the lower part of the concha, or expanded portion of the cartilaginous auditory canal.

The retrahens and the attollens aurem are supplied by the posterior auricular branch of the facial nerve; the attrahens, by an offset from the temporal branch of the same nerve.

Arteries of Scalp. — The *arteries* of the scalp are derived, in front, from the *supra-orbital* and *frontal* arteries, branches of the ophthalmic artery, which is a branch of the internal carotid; on the sides, from the *temporal;* behind from the *occipital* and *posterior auricular*, all branches of the external carotid.

The *frontal* emerges from the orbit at its inner angle; it runs upwards for a short distance on the forehead and inosculates with the following artery.

The *supra-orbital* passes through the supra-orbital notch and then divides into

a superficial and a deep branch. It distributes branches, some of which ascend toward the top of the head and communicate with the temporal and frontal arteries.

The *temporal*, about two inches above the zygoma, divides into two branches — an anterior and a posterior. The anterior runs forwards in a tortuous course and anastomoses with the supra-orbital and frontal arteries; the *posterior* (usually the larger) arches backwards over the temporal fascia, and its branches communicate with the corresponding branch of the opposite side and with the occipital and posterior auricular arteries.

The *posterior auricular* is a small vessel seen in the cleft between the ear and the mastoid process. It ascends, and divides into two branches: one, the mastoid or occipital, which passes backwards and inosculates with the occipital; the other, the auricular, which runs forwards above the ear and communicates with the posterior branch of the temporal artery.

The *occipital* may be noticed piercing the trapezius near to the external occipital protuberance; ascending over the back of the head, it divides into numerous branches which inosculate with the preceding arteries.

Fig. 2.— Diagram of the Sensory Nerves of the Scalp and Face.

1 Great occipital. 2. Small occipital. 3. Auricular br. of the pneumogastric. 4. Great auricular. 5. Auriculo temporal. 6. Temporal br. of maxillary nerve. 7. Supra-orbital. 8. Supratrochlear. 9. Malar br. of maxillary nerve. 10. Infra-trochlear. 11. Nasolobular. 12. Infraorbital. 13. Buccal br. of mandibular nerve. 14. Mental.

The frontal vein passes downwards with its corresponding artery, and joins the supra-orbital vein, to form the angular vein. The other veins of the scalp accompany their respective arteries.

Nerves of the Scalp. — The sensory nerves of the scalp are derived from each of the three divisions of the fifth cranial nerve — namely, the ophthalmic, the maxillary and mandibular; also from the second cervical nerve. The nerves to the

muscles of the scalp and ear come from the facial seventh cranial nerve.

In front will be found the supra-trochlear and supra-orbital nerves; in the temporal region, there are the temporal filament from the orbital branch of the maxillary, the auriculo-temporal, and the temporal branches of the facial nerve; and behind will be seen the posterior auricular branch of the facial, the small and great occipital nerves, and occasionally a small filament from the posterior division of the sub-occipital nerve.

The *supra-trochlear nerve* is derived from the frontal branch of the ophthalmic division of the fifth. It appears at the inner angle of the orbit, and ascending beneath the orbicularis palpebrarum and occipito-frontalis, it finally supplies the skin of the forehead and the upper eyelid.

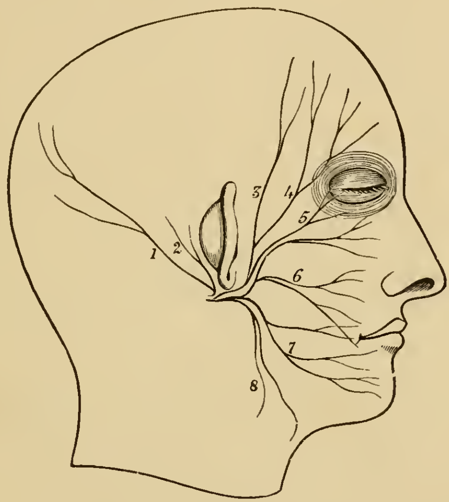


FIG. 3. — DIAGRAM OF THE BRANCHES OF THE FACIAL NERVE.
1. Branch to occipito-frontalis. 2. Posterior auricular. 3. Temporal brs. 4. Malar brs. 5. Infra-orbital. 6. Buccal. 7. Supra-maxillary. 8. Infra-maxillary.

The *supra-orbital nerve* is a continuation of the frontal branch of the fifth. It emerges from the orbit through the notch in the frontal bone, and subdivides into branches, which are covered at first by the fibres of the orbicularis and occipito-frontalis; but they presently become subcutaneous, and terminate in two branches — an *inner*, which ascends, to supply the structures as high as the parietal bone; and an *outer* and larger, which may be traced over the vertex as far as the occipital bone.

The *temporal branch* of the *orbital branch* of the maxillary nerve pierces the temporal fascia about an inch above the zygoma and is distributed to the skin of the temple, communicating with the facial nerve and occasionally with the following.

The *auriculo-temporal nerve*, a branch of the mandibular nerve, after sending

a small filament to the upper part of the pinna, divides into two branches which accompany the divisions of the superficial temporal artery; of these, the posterior is the smaller. The anterior communicates with the facial nerve, and with the orbital branch of the maxillary.

The *temporal branches* of the facial nerve lie superficial to the temporal fascia, and supply the attrahens and attollens aurem, the orbicularis palpebrarum, the corrugator supercilii, and the occipito-frontalis. These branches communicate with the temporal branch of the maxillary, the auriculo-temporal nerve, and with the lacrymal and supra-orbital branches of the ophthalmic.

The *posterior auricular nerve* is a branch of the facial, and divides like its accompanying artery behind the pinna of the ear into a *posterior* or *occipital* branch which supplies the posterior belly of the occipito-frontalis, and into an *anterior* or *auricular* branch which ends in the auricle, the retrahens, and attollens aurem. It communicates with the great auricular and small occipital nerves, and with the auricular branch (Arnold's) of the pneumogastric.

The *auricular branch of the pneumogastric* (Arnold's) emerges from the auricular fissure immediately behind the pinna, and supplies the skin of the pinna and the neighborhood.

The *great occipital nerve* is the internal branch of the posterior division of the second cervical nerve. After piercing the complexus it appears on the occiput with the occipital artery, and divides into wide-spreading branches which supply the skin. It communicates with the posterior auricular, the small occipital, and the third cervical nerves.

The *small occipital nerve*, a branch of the anterior division of the second cervical nerve, runs along the posterior border of the sterno-mastoid and supplies the scalp behind the ear. It communicates with the great auricular, and with the two preceding nerves.

Occasionally, though rarely, a cutaneous branch of the *suboccipital nerve* is distributed to the back of the head.

Lymphatics of the Scalp. — The lymphatics of the scalp run for the most part backwards towards the occiput to join the occipital and posterior auricular glands; a few run towards the root of the zygoma, where they enter the parotid lymphatic glands. It is in these situations, therefore, that one finds glandular enlargements when the scalp is diseased.

Points of Surgical Interest. — Raise the aponeurosis of the scalp, and observe the quantity of loose connective tissue which intervenes between it and the pericranium. This tissue never contains fat. There are some points of surgical interest concerning it: 1. Its looseness accounts for the extensive effusions of blood which one often sees after injuries of the head. 2. It admits of large flaps of the scalp being detached from the skull-cap; but these flaps rarely slough, unless severely damaged, because they carry their blood-vessels with them. In phlegmonous erysipelas of the scalp, the connected tissue becomes infiltrated with pus and sloughs; hence the necessity of making incisions; for the scalp will not lose its vitality and liberate the sloughs, like the skin of other parts under similar conditions, because its vessels run above the diseased tissue, and therefore its supply of blood is not cut off.

The alveolar point. — The centre of the ventral surface of the alveolar arch.

The asterion (ἀστήρ, a star). — The star-shaped suture made by the junction

of the mastoid portion of the temporal, the occipital, and post inferior angle of the parietal bones. It may be measured from the auricular point on a line continuous with the cephalad margin of the zygoma about two inches (5 c.m.). It indicates the position of the extreme lateral portion, the lateral sinus, and the commencement of the sigmoid portion of the same. A line drawn vertical from the asterion one inch (2.5 c.m.) locates the entrance of the mastoid vein when present.

The basion (βάσις, a base). — The centre of the ventral or anterior margin of the foramen magnum. A line drawn horizontally bisects each bony external auditory meatus, or *auricular point.*

The bregma (βρέγμα, from βρέχειν, to moisten, being the soft part of the infant skull). — The point of union of the interparietal and fronto-parietal sutures.

The glabella (glabellus, without hair). — A prominence (sometimes a depression) above the nasion, between the superciliary ridges, corresponding to the basal surface of the frontal cerebral lobes.

The inion (ἰνίον, the occiput). — The external occipital protuberance. It is below the occipital point, and is consequently nearer to the glabella in the transcephalic measurement.

The lambda (from the Greek letter Λ). — The junction of interparietal and the parieto-occipital sutures.

The nasion (nasus, the nose). — Mid point of junction of internasal and naso-frontal sutures.

The obelion (ὀβελός, a spit). — Being the point of intersection of the sagittal suture and a line through the parietal foramen.

The occipital point. — That point on the median of the occiput line farthest removed from the glabella.

The ophryon (ὀφρύς, the eyebrow) or supra orbital point. — The centre of a line drawn transversely at the narrowest portion of the forehead, being the line of separation between cranium and face.

The opisthion (ὀπίσθιος, hinder). — The centre of dorsal or posterior margin of the foramen magnum. A line drawn horizontally at this point, and another bisecting the emenentia articularis marks the limits of the sub-cranial region. That portion posterior or dorsal to the opisthionic line bisects the sub-occipital region.

The pterion (πτέρον, a wing). — The H-shaped suture made by the junction of the frontal, temporal, parietal, and the temporal fossa surface of the great wing of the sphenoid bones. It may be located on a line drawn parallel to the zygomatic arch from the external angular process of the frontal bone. It is about one and one-half to two inches from the angular process, and the same distance from the centre of the upper or cephalad margin of the zygoma. It is of surgical importance from the relation of the anterior trunk of the large meningeal artery passing obliquely from below upward (caudo-cephelad) between the ventral and dorsal portion of this suture. The separation between the basal portion of the frontal lobe and the superior or cephalad portion of the tempero-sphenoidal lobe. It also marks the division of the fissure of Sylvius into its vertical and horizontal portions. There is often a sesamoid bone situated here, the *epipteric bone of Flower*, which may be mistaken for a fracture.

The Stephanion (στεφάνιον, dim. of στεφάνος, a crown). — The point where the temporal ridge crosses the fronto-parietal suture. The anterior or ventral branch of the anterior dural artery is usual at this point. The inferior frontal sulcus is also in close proximity.

Circumference of the skull should be made in a plane passing from the ophryon to the occipital point. The maximum cranial length is measured from the most prominent portion of the glabella to the occipital point. The maximum breadth is the greatest transverse diameter of the cranium measured above the supramastoid ridge to the median plane. The cephalic index is therefore $\left(\frac{100 \times \text{breadth}}{\text{length}}\right)$. The height of the cranium is measured from the basion to the bregma. The index of height is less subject to variation than the breadth-index.

The sub-nasal. — The centre of the caudal or inferior border of the ventral or anterior nares, being at the base of the spine.

If the skin has been removed from the face in dissecting its nerves, the student is advised to continue the facial dissection, as in well-injected subjects the brain will keep well in the skull.

Dissection. — To examine the brain and its membranes, the skull-cap must be removed about half an inch above the supra-orbital ridges in front, and on a level with the occipital protuberance behind. The student should remember that the bone in the temporal region is very thin, and that here especial care is needed that the brain be not injured by the saw. It is better to saw only through the outer table of the skull, and to break through the inner with a chisel. In this way the dura and the brain are less likely to be injured. On removing the skull-cap, which is more or less intimately attached to the subjacent membrane, we expose a tough fibrous layer, *the dura*, which forms the most external of the membranes of the brain.

The meningeal or dural arteries ramify between the skull and the dura. We cannot, however, with the brain *in situ*, trace their course, at present, throughout ; so their consideration must be deferred until the brain has been removed.

Dura.* — This membrane is a dense white fibrous membrane, rough on its outer aspect, where it is more or less adherent to the inner surface of the skull, forming its internal periosteum. On its inner surface it is smooth and shining, being lined by a layer of endothelial cells, which anatomists now describe as constituting a part of the dura. In consequence, the term "*subdural space*" is now substituted for the old one — "*the cavity of the arachnoid*." The dura differs in its adhesion to the subjacent bones : its adhesion is firmest at the sutures, the petrous portion of the temporal bone, the basilar process, the body of the sphenoid, the cribriform plate of the ethmoid bone, the depressions for the Pacchionian bodies, and at the margin of the foramen magnum. In front it sends downwards a prolongation into the foramen cæcum ; also numerous small tubular sheaths through the foramina in the cribriform plate. It further sends a prolongation through the optic foramen, and another through the sphenoidal fissure into the orbit.

The dura is supplied with *nerves* by the recurrent branch of the fourth nerve, and by the fifth cranial nerve. Filaments have likewise been traced into it from the sympathetic and from the Gasserian ganglion.

* The dura is divided into two inseparable layers. The outer or periosteal lamina and an inner of supporting lamina. It is to the latter lamina that sinuses owe their formation for the most part.

Its remarkably tough and fibrous structure adapts it exceedingly well to the four purposes which it serves: 1. It forms the internal periosteum of the skull. 2. It forms, for the support of the lobes of the brain, three partitions — namely, the falx, the falcula, and the tentorium.* 3. It forms the sinuses or venous canals which return the blood from the brain. 4. It forms sheaths for the nerves as they leave the skull.

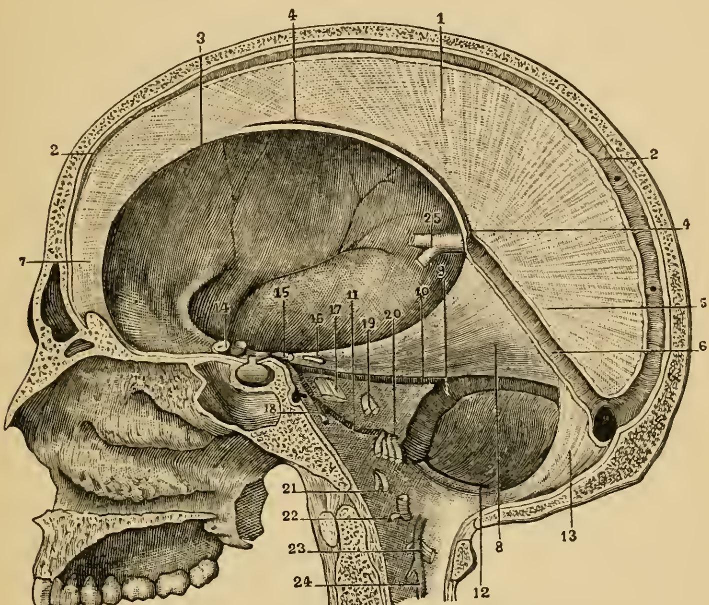


FIG. 4.

1. Falx. 2, 2. Its convex border enclosing the superior longitudinal sinus. . Its concave border. 4, 4. Inferior longitudinal sinus. 5. Base of the falx. 6. Straight sinus. 7. Apex of the falx attached to the crista galli. 8. Right half of the tentorium from the interior surface. 9. Right lateral sinus. 10. Superior petrosal sinus. 11. Inferior petrosal sinus. 12. Occipital sinus. 13. Falcula. 14. Optic or second nerve. 15. Third nerve. 16. Fourth nerve. 17. Fifth nerve. 18. Sixth nerve. 19. Seventh and eighth nerves. 20. Ninth, tenth, and eleventh nerves. 21. Twelfth nerve. 22. First pair of cervical nerves. 23. Second pair of cervical nerves. 24. Superior end of linamentum denticulatum. 25. Venæ Galeni.

Of the partitions formed by the dura for the support of the lobes of the brain, two are vertical, and separate, respectively, the two hemispheres of the cerebrum and those of the cere-

* Meckel's space is formed by the separation of the two layers enclosing the Gasserian ganglion. The diaphragma sellae is formed by the dura proper attached to the clinoid processes and having a perforation in its centre for the infondibulum to pass to the petuitary body.

bellum; the third arches backwards, and supports the posterior lobes of the cerebrum.

Falx. — This partition is named, from its resemblance to the blade of a sickle, *falx*. It is received into the longitudinal fissure, and separates the two cerebral hemispheres. It begins in a point attached to the *crista galli*, and gradually becomes broader as it extends backwards. Its upper edge is convex, and attached to the median groove on the inner aspect of the vertex of the skull; its lower margin is concave and free, and runs along the upper aspect of the callosum. From its base or broadest part proceeds the sloping arched partition named *tentorium*. This forms an arch for the support of the posterior lobes of the cerebrum, so that they may not press upon the cerebellum beneath. The tentorium is attached to the transverse ridge of the occipital bone, to the superior border of the petrous portion of the temporal bone, and to the posterior and anterior clinoid processes of the sphenoid. In front there is a large oval opening to allow of the passage of the crura. The small median partition which separates the lobes of the cerebellum is called the *falcula*. It is placed vertically in the same plane with the falx, and its point is downwards towards the foramen magnum. As it approaches the foramen it usually divides into two small folds.

Glandulæ Pacchioni. — In the neighborhood of the superior longitudinal sinus, we meet with small white elevated granulations, sometimes arranged singly, sometimes in clusters, which are received into the depression on the inner aspect of the skull-cap. They are termed *glandulæ Pacchioni*, and are found in four situations: 1. On the outside of the dura, close to the superior longitudinal sinus, and so large as to occasion depressions in the bones. 2. Along the margin of the fissure of Sylvius. 3. On the surface of the pia. 4. In the interior of the superior longitudinal sinus, covered by its lining membrane. 5. On the posterior and antero-inferior parts of the posterior lobe of the cerebrum.

They are due to an increased growth of the villi, which are normally found in the arachnoid membrane, and make their way, through the dura or the pia, to the different situations in which they are found. The greatest growth takes place from the visceral layer, as may be seen in the dissection of the brain. These bodies are not found at birth, but usually commence their growth about the third year, and are always found at the seventh year, after which they gradually increase as life advances.

Sinuses of the Dura. — It is one of the peculiarities of the cerebral circulation, that the blood is returned through canals or *sinuses* formed by the dura. These canals are produced by a splitting of the dura into two layers as shown in Fig. 5, where 1 represents a vertical section through the superior longitudinal sinus. They are lined by the same smooth membrane continuous with that of the venous system. Since their walls consist of unyielding structure, and are always on the stretch, it is obvious that they are admirably adapted to resist the pressure of the brain. There are fifteen of these sinuses, and they are classified into two groups — a *supero-posterior* and an *infero anterior*. The supero-posterior group comprises the superior longitudinal, the inferior longitudinal, the straight, the lateral, and the occipital sinuses; while the infero-anterior group includes the cavernous, the circular, the superior, and inferior petrosal, and the straight sinuses. Of these fifteen sinuses, five are pairs and five are single, as follows: —

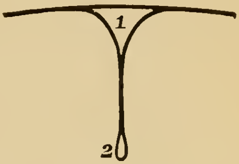


Fig. 5. — Diagram to show Formation of a Sinus.

The five pairs of sinuses are —
The lateral.
The superior petrosal.
The inferior petrosal.
The cavernous.
The occipital.

The five single sinuses are —
The superior longitudinal.
The inferior longitudinal.
The circular.
The transverse.
The straight.

The blood from all these sinuses is eventually discharged into the internal jugular veins.

Superior Longitudinal Sinus. — This runs along the upper attached border of the falx (Fig. 6). It begins very small at the foramen cæcum, gradually increases in size in its course backwards, and opposite the internal protuberance of the occipital bone opens into a triangular dilatation, the *torcular* or the *confluence of the sinuses*. It then divides into the right and left lateral sinuses, the right being generally the larger. Besides numerous veins from the cancellous texture of the skull-cap, the superior longitudinal sinus receives large veins

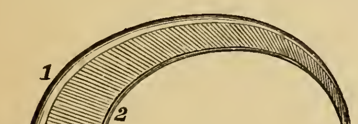


Fig. 6.
1. Superior longitudinal sinus. 2. Inferior longitudinal sinus. 3. Straight sinus. 4, 4. Venæ Galeni.

from the upper part of each hemisphere of the cerebrum, and an emissary vein through the parietal foramen. It is interesting to observe that these veins run (as a rule) from behind forward, contrary to the current of blood in the sinus, and that they pass through the wall of the sinus very obliquely, like the ureter into the bladder. The probable object of this oblique entrance is to prevent regurgitation of blood from the sinus into the veins of the brain.

Cut open the superior longitudinal sinus: observe that it is triangular with its base upwards, and that its cavity is intersected in many places by slender fibrous cords, termed *chordæ Willisii.* Their precise use is not understood.

The brain should now be removed, and preserved in alcohol, 95 proof, for future examination. Its anatomy, with that of its remaining membranes, will be described in a subsequent part of this work.

Dissection. — The brain is to be removed in the following manner: The dura should be cut through with a pair of scissors on a level corresponding with the sawn calvaria, care being taken to cut completely through the falx in the front part of the longitudinal fissure. Now lift up gently, with the fingers of the left hand, the frontal lobes from the anterior fossæ, taking care to raise with the brain the soft olfactory lobes from the cribriform plate of the ethmoid. Two white flat nerves — the optic — come into view prior to their leaving the skull through the optic foramina; these must be divided with a sharp knife together with the ophthalmic arteries which lie beneath the corresponding nerves. In the middle line, fixed firmly in the sella turcica, lies the pituitary body (hypophisis), attached to the brain by a process — the infundibulum. It is not easy to remove this body from the fossa in which it rests, owing to its being retained in its position by dura (*diaphragma sellae*). When this is removed, two round white nerves — the third — are observed, one on each side, lying on the inner free border of the tentorium, immediately behind the anterior clinoid process of the sphenoid. Divide these and then proceed to cut through the tentorium close to its attachment to the posterior clinoid process and the upper border of the petrous portion of the temporal bone, as far back as the lateral sinus. If this be done with care, the nerves lying beneath the tentorium will not have been injured. Immediately external to the third nerves are the slender fourth nerves; and still further outside are the soft, flattened fifth nerves. Cut

these through, still gently raising the brain from the skull base, when the seventh pair come into view as they pass backwards and outwards towards the internal auditory foramina. When these have been cut, we notice the two sixth nerves running directly forwards to pierce the dura covering the basilar process of the occiput. Divide these as they pierce the dura, when the ninth, tenth, and eleventh nerves are brought well into view, lying behind and internal to the seventh and eighth ; the anterior one is the glosso-pharyngeal or ninth ; the middle one is the pneumogastric, tenth, and the hindermost one is the spinal accessory, eleventh, whose spinal portion can be traced coming up from the foramen magnum. These all emerge through the jugular foramina. Below and internal to these are the hypoglossal or twelfth, nerves, which usually pass through the dura in two fasciculi. Cut these, and then pass down the knife as far into the spinal canal as possible, and cut through the spinal cord, the two vertebral arteries, and the spinal portions of the spinal accessory nerves. Now lay the knife aside, when by gentle traction the brain can be easily removed from the skull.

The other sinuses should now be examined.

Lateral Sinuses. — These are the two great sinuses through which all the blood from the brain is returned to the jugular veins. Their course is well marked in the dry skull. The right is usually the larger. Each commences at the internal occipital protuberance, and proceeds at first horizontally outwards, enclosed between the layers of the tentorium, along a groove in the occipital bone and the posterior inferior angle of the parietal ; it then descends along the mastoid portion of the temporal bone, and again indenting the occipital bone, turns forwards to the foramen lacerum posterius, and terminates in the bulb of the internal jugular vein, where it is joined by the inferior petrosal sinus. It receives blood also from the inferior cerebral and cerebellar veins, from the diploë, and the superior petrosal sinus. It communicates with the veins of the scalp through emissary veins, which pass through the mastoid and posterior condylar foramina.

Inferior Longitudinal Sinus. — This is of small size. It runs in the inferior free border of the falx, and terminates in the straight sinus at the anterior margin of the tentorium (Fig. 6).

Straight Sinus. — This may be considered as the continuation of the preceding. It runs along the line of junction of the

falx with the tentorium, and terminates in the torcular at the divergence of the two lateral sinuses. It receives the inferior cerebral and the superior cerebellar veins, and also the two *venæ Galeni* (Fig. 6), which return the blood from the lateral and third ventricles of the brain.

Cavernous Sinus. — This is so called because its interior is intersected by numerous cords. It extends along the side of the body of the sphenoid bone, outside the internal carotid artery. It receives the ophthalmic vein which leaves the orbit

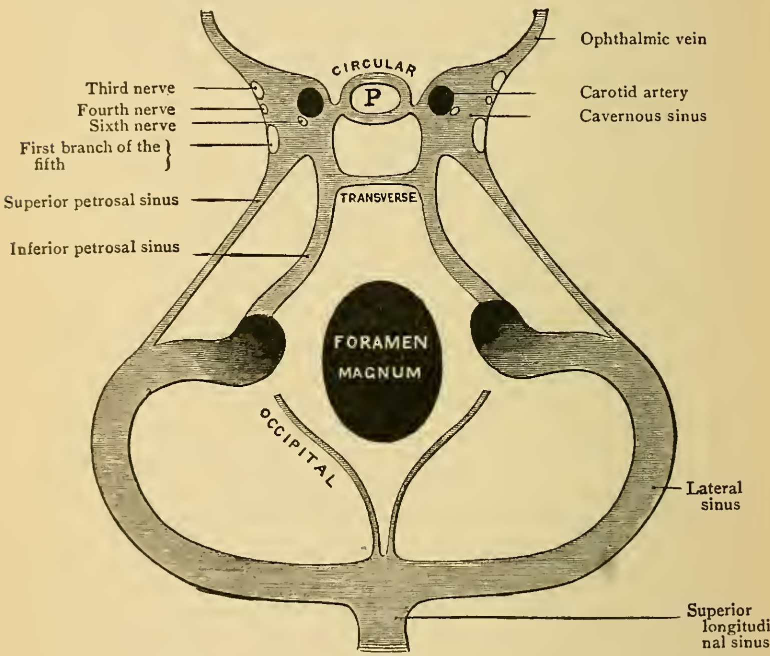


Fig. 7. — Diagram of the Venous Sinuses at the Base of the Skull.

through the sphenoidal fissure and the anterior inferior cerebral veins; it communicates with the circular sinus which surrounds the pituitary body or hypophisis (Fig. 7). At the apex of the petrous portion of the temporal bone it divides into the superior and inferior petrosal sinuses.

Circular Sinus. — This surrounds the pituitary body or hypophisis (P in Fig. 7), and communicates on each side with the cavernous sinus. The posterior branch is sometimes absent.

There may be three channels, one in front, usually the largest, another behind, and a very small one inferiorly, all connecting the cavernous sinuses.

Petrosal Sinuses. — These lead from the cavernous to the lateral sinuses. There are two on each side. The *superior* runs along the upper portion of the pars petrosa, in the attached border of the tentorium; the *inferior*, the larger of the two, runs along the suture between the pars petrosa and the occipital bone, and ends in the lateral sinus just before this terminates in the internal jugular vein. The superior sinus receives the inferior cerebral, the superior cerebellar veins, and a small branch from the tympanum; the inferior sinus is joined by the inferior cerebellar and auditory veins.

Transverse Sinus. — This extends from one inferior petrosal to the other, across the basilar process of the occipital bone. It communicates below with the anterior spinal veins.

Occipital Sinuses. — These are very small. They commence around the margin of the foramen magnum, run in the falcula, and uniting to form a single sinus, open into the torcular. They join inferiorly with the posterior spinal veins.

Meningeal or Dural Arteries. — These arteries ramify between the skull and the dura. Their course may be traced by the grooves which they make in the bones. They are termed *anterior*, *middle*, and *posterior*, from the fossæ in which they ramify.*

The *anterior meningeal* are derived from the ethmoidal branches of the ophthalmic artery and the cavernous portions of the internal carotid. They supply the dura in the neighborhood of the ethmoid bone.

The *middle meningeal* are three in number; the most important is the *arteria meningea or magna media*, a branch of the internal maxillary artery. It enters the skull through the foramen spinosum, and divides into two principal branches: one, the anterior, runs in a groove near the anterior border of the parietal bone; the other, the posterior, curves backwards over the temporal bone, and subsequently ramifies on the parietal bone. The artery gives off a small branch — the *petrosal* — which enters the hiatus Fallopii and anastomoses with the stylo-mastoid artery in the aquæductus Fallopii; one or more anastomosing branches which enter the orbit through the sphenoidal fissure to communicate with the ophthalmic artery; and some temporal branches which pierce the sphenoid bone to enter the temporal fossa. It is accompanied by two veins which empty themselves into the internal maxillary vein. The *arterea menengea parva*, which enters the skull through the foramen ovale, and a *meningeal branch* from the ascending pharyngeal artery, which comes up through the foramen lacerum medium, also supply the dura and bones of the middle fossa.

The *posterior meningeal* come from the occipital, the ascending pharyngeal, and the vertebral arteries; the two former enter the skull through the foramen jugulare, and the latter through the foramen magnum. The meningeal veins, with the exception of the middle meningeal, open into the various sinuses.

* A prædural, medidural, postdural, parvidural.

The position of the meningeal arteries renders them liable to injury in fractures of the skull; hence extravasation of blood between the skull and dura is one of the common causes of compression of the brain.

Dissection. — The student should now examine the cranial nerves as they pass out through the foramina in the base of the skull, and then dissect the cavernous sinus.

Exit of the Cranial Nerves. — The cranial nerves proceed in pairs through the foramina at the base of the skull; they are named first, second, third, fourth, etc., pairs, according to the order of succession from before backwards. As they pass through the foramina, each receives a process from the three membranes of the brain, the dura, the pia, and the arachnoid; the two first are gradually lost upon the nerve, while the arachnoid is reflected back.

The *first* is the *olfactory nerve.* This cannot be seen, because the olfactory bulb has been removed with the brain. From the under aspect of the bulb proceed about twenty branches, which pass through the foramina in the cribriform plate of the ethmoid bone, and are arranged in two groups, — inner and outer. The *inner* (smaller) pass to the septum nasi; and the *outer* (larger) to the outer wall of the nose as low as the middle turbinated bone.

The *second* (*optic nerve*) passes through the foramen opticum into the orbit accompanied by the ophthalmic artery.

In order to see the next three pairs of nerves, the dura must be carefully removed from the side of the body of the sphenoid, and the nerves traced as they pass through the tentorium.

The *third* (*motor oculi*) passes through the dura, close behind the anterior clinoid process, traverses the outer wall of the cavernous sinus, and enters the orbit through the sphenoidal fissure, where it receives some filaments from the cavernous plexus of the sympathetic.

Before passing through the fissure, it divides into two branches, an upper and a lower, which enter the orbit between the two heads of the external rectus.

The *fourth* (*trochlearis*), a small nerve, passes through the dura a little behind the posterior clinoid process. It passes through the outer wall of the cavernous sinus, lying below the preceding nerve and above the first division of the fifth, and then runs forwards through the sphenoidal fissure. Here it lies above the third nerve, and is finally distributed to the superior oblique muscle, on its orbital surface.

In passing through the cavernous sinus it receives some branches from the sympathetic plexus. It also communicates here with the ophthalmic nerve, and sends back a recurrent branch to supply the tentorium as far back as the internal occipital protuberance.

The *fifth* (*trifacial*) nerve passes through an aperture in the dura beneath a tentorium attached to the elevated margins of

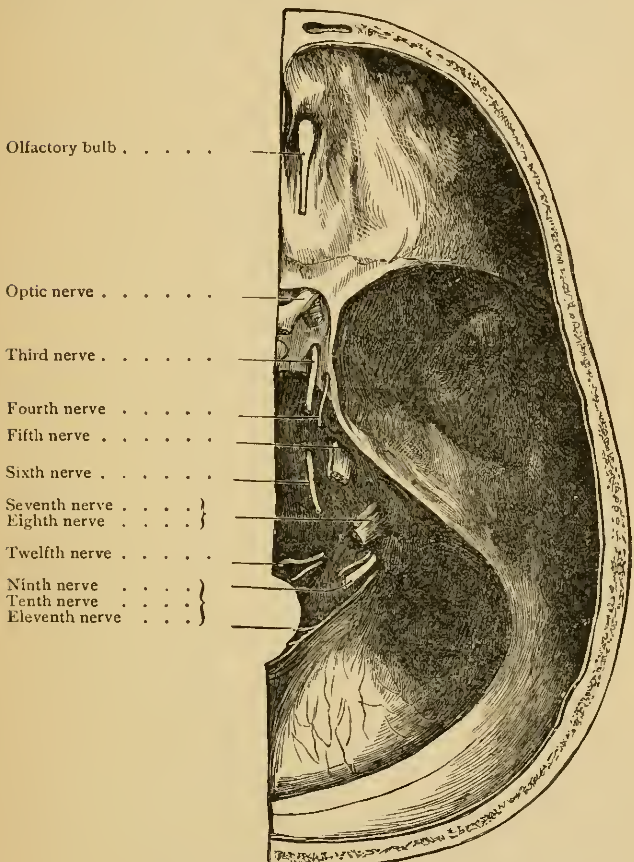


FIG. 8. — DIAGRAM OF THE EXIT OF THE CRANIAL NERVES.

the concave surface on the anterior part of the pars petrosa at its apex. It consists of two parts — a larger or sensory root, and a smaller or motor. Upon its larger or sensory root is developed a large ganglion, the *Gasserian ganglion;* while the motor root lies below and unconnected with it. From this gan-

glion proceed the three primary divisions of the nerve — the *ophthalmic*, which passes through the outer wall of the cavernous sinus below the fourth nerve, and subsequently enters the orbit through the sphenoidal fissure.

While in the cavernous sinus this nerve receives filaments of communication from the cavernous plexus, and also sends back a recurrent branch to supply the tentorium (Arnold); the ophthalmic nerve is frequently intimately connected with a branch of the fourth nerve; it is also connected by a small branch with the sixth nerve.

The *maxillary*, which gives off a small recurrent branch to the dura and middle meningeal artery, and then leaves the skull through the foramen rotundum; and the mandibular, which passes through the foramen ovale. The smaller or motor root of the fifth lies beneath the ganglion, with which it has no communication, and then joins the mandibular division to supply the muscles of mastication with motor power.

The *sixth* (*abducens*) nerve pierces the dura behind the body of the sphenoid bone, which it grooves. It then passes along the inner wall of the cavernous sinus, external to the internal carotid artery, and enters the orbit through the sphenoidal fissure to supply the external rectus, between the two heads of which it passes. It is connected, as it passes along the inner wall of the cavernous sinus, with the cavernous plexus, the ophthalmic nerve, and in the orbit with Meckel's ganglion.

The *seventh* or *facial nerve* passes through the meatus auditorius internus, together with the auditory nerve and artery. As it passes along the meatus it is separated from the auditory nerve, upon which it lies, by the *portio intermedia of Wrisberg*. At the bottom of the auditory meatus, the facial nerve leaves the auditory to traverse a tortuous bony canal, the "aquæductus Fallopii." In the meatus auditorius, the facial and the auditory nerves are connected by small filaments.

The *eighth* or *auditory nerve* passes outwards through the internal auditory meatus in company with the preceding nerve. It is the larger of the two nerves, and lies below the facial, which lies in a groove on this nerve. In the meatus the auditory divides into two branches, cochlear and vestibular.

The *ninth* or *glosso-pharyngeal nerve* passes through the jugular foramen in front of the pneumogastric and spinal accessory nerves. This nerve has a separate tube of dura and arachnoid, and lies in a groove in the lower border of the pars petrosa of the temporal bone, together with the two succeeding nerves (Fig. 9).

The *tenth* or *pneumogastric* nerve emerges through the jugular foramen behind and rather internal to the glosso-pharyngeal. It is enclosed in a common sheath of dura with the spinal accessory, but is separated from it by a thin septum of arachnoid membrane.

The *eleventh or spinal accessory* also passes through the foramen jugulare, lying behind the preceding nerve.

The *twelfth* or *hypoglossal nerve* passes through the anterior condylar foramen, piercing the dura by two fasciculi which unite external to the skull.

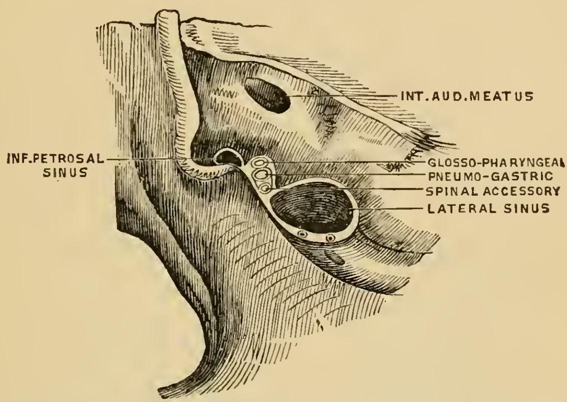


FIG. 9.—DIAGRAM SHOWING THE RELATIONS OF THE VESSELS AND NERVES PASSING THROUGH THE FORAMEN JUGULARE.

Dissection.—We must now examine the cavernous sinus, and the nerves which course along its walls to the orbit—namely, the third, the fourth, the ophthalmic division of the fifth and the sixth nerves.

Cavernous Sinus.—This sinus (Fig. 7) lies by the side of the body of the sphenoid bone. In front it receives the ophthalmic vein, which passes backwards through the sphenoidal fissure; while posteriorly it divides into the superior and inferior petrosal sinuses, which have been already described; on the inner side it communicates with the circular sinus, which surrounds the pituitary body or hypophisis (P in Fig. 7). The interior of the sinus is remarkable for the numerous fine bands of reticular tissue which interlace in all directions.

In the outer wall of the cavernous sinus we trace, from above downwards, the third nerve, the fourth, and the ophthalmic di-

vision of the fifth, in their course to the orbit. On its inner wall are situated the internal carotid artery with the sixth nerve below and to its outer side. These structures are not actually

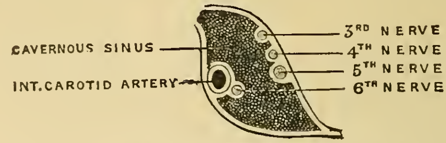


FIG. 10.—RELATION OF THE VARIOUS STRUCTURES PASSING THROUGH THE CAVERNOUS SINUS.

within the sinus so as to be bathed by the blood, for they are separated from it by the lining membrane of the sinus (Fig. 10).

Relative Positions of Nerves in Sphenoidal Fissure.—These nerves should be traced from the cavernous sinus, forwards, so as to see how they alter their relative positions before entering the sphenoidal fissure, and, again, in their passage through it.

Just *before entering the sphenoidal fissure*, the fourth nerve (on its way to the orbital surface of the superior oblique) gets above the third, which here divides into an upper and a lower branch (both proceeding to the ocular surface of the muscles they supply); lower still, we have the frontal, lachrymal, and nasal divisions of the ophthalmic; lowest of all is the sixth nerve on its way to the external rectus.

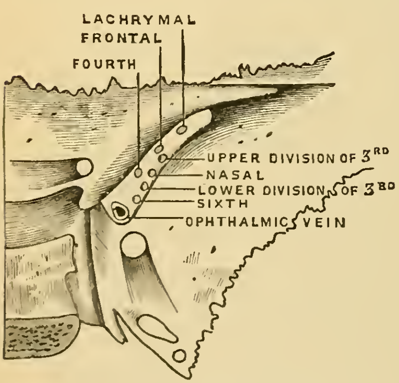


FIG. 11.—DIAGRAM OF THE RELATIONS OF THE NERVES AS THEY PASS THROUGH THE SPHENOIDAL FISSURE.

In their passage through the sphenoidal fissure, we find that the fourth nerve, the frontal, and lachrymal branches of the ophthalmic, lie at the top, on nearly the same level, and they enter the orbit above the muscles in this order from within outwards. Lower, and in the following order from above downwards, come the upper division of the third, the nasal branch of the ophthalmic, the lower division of the third, and the sixth; all of which (with the ophthalmic vein) enter the orbit between the two origins of the rectus externus (Fig. 11).

At the *back of the orbit* the relation of these nerves is further altered. The fourth, frontal, and lachrymal are still on the same level: the upper division of the third is below the superior rectus, and above the optic nerve is the nasal nerve; the sixth is on the inner side of the external rectus, while the lower division of the third is below and to the outer side of the optic nerve, close to which is the lenticular ganglion [Fig. 12].

The dissector will better remember the varying relations of these nerves when he has learnt their respective destinations.

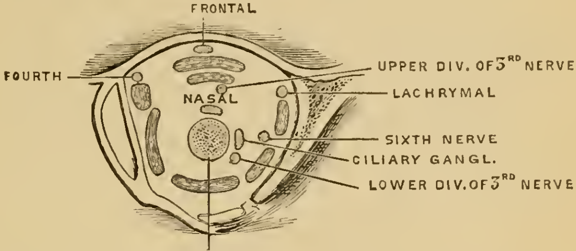


Fig. 12.—Relations of the Nerves and Muscles at the Back of the Orbit.

Curves of the Carotid Artery. — After the removal of the cavernous sinus, a good view is obtained of the curves, like the letter S, made by the internal carotid artery on the side of the pituitary fossa. The vessel enters the cranium at the apex of the petrous portion of the temporal bone, makes its sigmoid curves within the cavernous sinus, and then passes through the dura, between the anterior clinoid process and the optic nerve, where it gives off the ophthalmic artery. Within the cavernous sinus, small branches, *arteriæ receptaculi*, arise from the carotid and supply the pituitary body and the walls of the sinus.

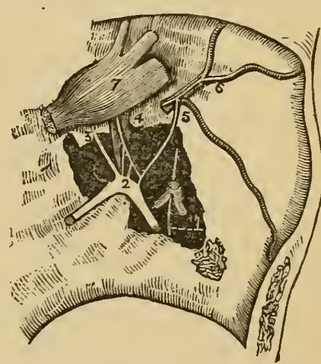


Fig. 13.—The Geniculate Ganglion of the Facial Nerve.

1. The chorda tympani. 2. The geniculate ganglion of the facial nerve. 3. The great petrosal nerve. 4. The lesser petrosal nerve lying over the tensor tympani. 5. The external petrosal nerve communicating with the sympathetic plexus on the arteria meningea media (6). 7. The Gasserian ganglion.

A careful dissection would show a plexus of sympathetic nerves on the outer side of the internal carotid artery, as it lies by the side of the body of the sphenoid. This is the carotid plexis. It is connected by numerous filaments with the sixth nerve and the Gasserian ganglion. It further furnishes the large deep petrosal nerve which unites with the large superficial petrosal nerve of the facial to form the Vidian; and also the small deep petrosal nerve which joins probably the tympanic plexus. Those filaments of the sympathetic seen on the inner side of the

artery in the upper part of the cavernous sinus constitute the CAVERNOUS PLEXUS, which is in communication with the third, the fourth, and the ophthalmic division of the fifth nerves, and gives a branch to the lenticular ganglion in the orbit.

On removing the Gasserian ganglion, three small nerves are seen lying on the anterior surface of the petrous portion of the temporal bone. One, the *large superficial petrosal nerve*, enters the hiatus Fallopii to join the facial; the second, immediately external to the preceding, is the *small superficial petrosal*, which passes from the facial to join the otic ganglion; the third, the *external superficial petrosal nerve* (not always present), passes from the facial to communicate with the sympathetic on the middle meningeal artery.

DISSECTION OF THE FACE.

Much practice is required to make a good dissection of the face, and it is well, therefore, to dissect this part before the skin and adjacent structures get dry and discolored.

The muscles of expression are numerous and complicated; they are interwoven with the subcutaneous tissue and closely united to the skin: their fibres are often pale and indistinct. The face is largely supplied with motor and sensory nerves, of which the ramifications extend far and wide. Therefore you must not be discouraged if, in a first attempt, you fail to make a satisfactory display of the parts.

The cheeks and nostrils should be distended with horse-hair, and the lips sewn together.

Make an incision down the mesial line of the face; another from the chin along the base of the lower jaw to the angle; then prolong it, in front of the ear, to the zygoma. Reflect the skin from below upwards. Each muscle, to be properly cleaned, should be put on the stretch by hooks.

The student is recommended to make out the muscles and arteries on the one side, leaving the other side for the display of the nerves.

The motor nerve, which supplies all the muscles of expression in the face, is the '*portio dura*,' or facial nerve. It emerges from the stylo-mastoid foramen, and divides into branches, which pass through the parotid gland, forming a plexus termed the '*pes anserinus*.'

The sensory nerves of the face are chiefly derived from the

three divisions of the fifth cranial nerve; namely, the supra-orbital, the supra-trochlear, the lachrymal, the infra-trochlear, and naso-lobular, which latter supply the ala and the tip of the nose; the three sets of branches from the infra-orbital; and the mental. The other nerves, which confer sensation upon the face, are the great auricular branch of the cervical plexus, which supplies the skin covering the parotid gland and part of the cheek.

It is convenient to arrange the muscles of the face under three groups; appertaining, respectively, to the mouth, the nose, the eyebrows, and lids. Begin with those of the mouth.

The muscles of the mouth are arranged thus: there is an orbicular or sphincter muscle surrounding the lips; from this, as from a common centre, muscles diverge and are fixed into the surrounding bones. They are named elevators, depressors, sphincters, etc., according to their respective action.

Musculus Risorius (Santorini). — This muscle is usually considered as a part of the platysma myoides, the large subcutaneous muscle of the neck. It arises by thin fasciculi from the fascia over the masseter muscle, and passes horizontally forwards to be inserted into the angle of the mouth, where it intermingles with the orbicularis oris and depressor anguli oris. It produces the smile, not of good-humor, but of derision.

Obicularis Oris. — This muscle, nearly an inch in breadth, surrounds the mouth, forming a kind of sphincter. Its size and thickness in different individuals produce the variety in the prominence of the lips. Observe that its fibres, except the most internal, do not surround the mouth in one unbroken series, but that those of the upper and lower lip decussate at the angles of the mouth, and intermingle with the fibres of the buccinator and other muscles which converge from different parts of the face.

The orbicularis consists of two parts, an inner or *labial* part, and an outer or *facial;* the difference in appearance of the fibres being very marked. The *labial* part consists of pale, thin fibres, forming more or less of the inner part of the orbicularis, and has no attachment to bone; the *facial* part is thinner but broader, and besides being connected with other muscles, is attached to bone thus: in the upper lip by two fasciculi on each side, one to the septum nasi, the other to the alveolar border opposite the incisor teeth; in the lower lip by a single fasciculus to the mandible on each side opposite the canine tooth. The cutaneous surface of the muscle is intimately connected

with the lips and the surrounding skin; the deep surface is separated from the mucous membrane by the labial glands and the coronary vessels.

The orbicularis is the antagonist of all the muscles which move the lips. Upon a nice balance of their opposite actions depend the play and infinitely varied expression of the mouth.*

Depression Anguli Oris. — This muscle *arises* broadly from the oblique line of the mandible behind the foramen mentale, and is *inserted* narrowly into the angle of the mouth, intermingling with the zygomatici, the risorius, and orbicularis oris. It is an important muscle in the expression of sorrowful emotions. We see its action when children cry.

Depressor Labii Inferioris, or Quadratus Menti. — This muscle *arises* from the oblique line of the mandible below the foramen mentale, and is *inserted* into the lower lip, its fibres intermingling with those of its fellow of the opposite side and the orbicularis. It covers the vessels and nerves which emerge from the foramen.

Levator Menti, or Levator Labii Inferioris. — This muscle *arises* from the mandible, from the fossa below the incisor teeth, and, passing down, is *inserted* into the skin of the chin. To see it, evert the lower lip and remove the mucous membrane on either side of the frænum. There are two of them, one for each side. Their action is well seen when we shave the chin, or protrude the lower lip.

Zygomaticus Major and Minor. — The zygomaticus major *arises* from the outer surface of the malar bone close to its suture with the zygoma, passes obliquely downwards and inwards, and is *inserted* into the angle of the mouth, joining the depressor anguli and orbicularis oris.

The zygomaticus minor *arises* from the outer surface of the malar bone, in front of the preceding, and is *inserted* into the outer border of the levator labii superioris near the corner of the mouth. The zygomaticus minor is often absent. The zygomaticus major is the muscle of laughing: the minor expresses sadness.

Before examining the orbicularis palpebrarum, notice the

* In strong muscular lips the upper part of the orbicularis sends a small subcutaneous slip of muscle from each side along the septum nasi nearly to the apex. The interval between the two slips corresponds to the furrow which leads from the nose to the lip. This is the *naso-labialis* or *depressor septi narium* of Haller and Albinus.

tendo oculi. To make the tendon more apparent, the tarsal cartilages should be drawn outward.

Tendo Oculi or Palpebrarum. — This tendon is a thin cord about 4 mm. ($\frac{1}{6}$ in.) in length, and is readily felt at the inner angle

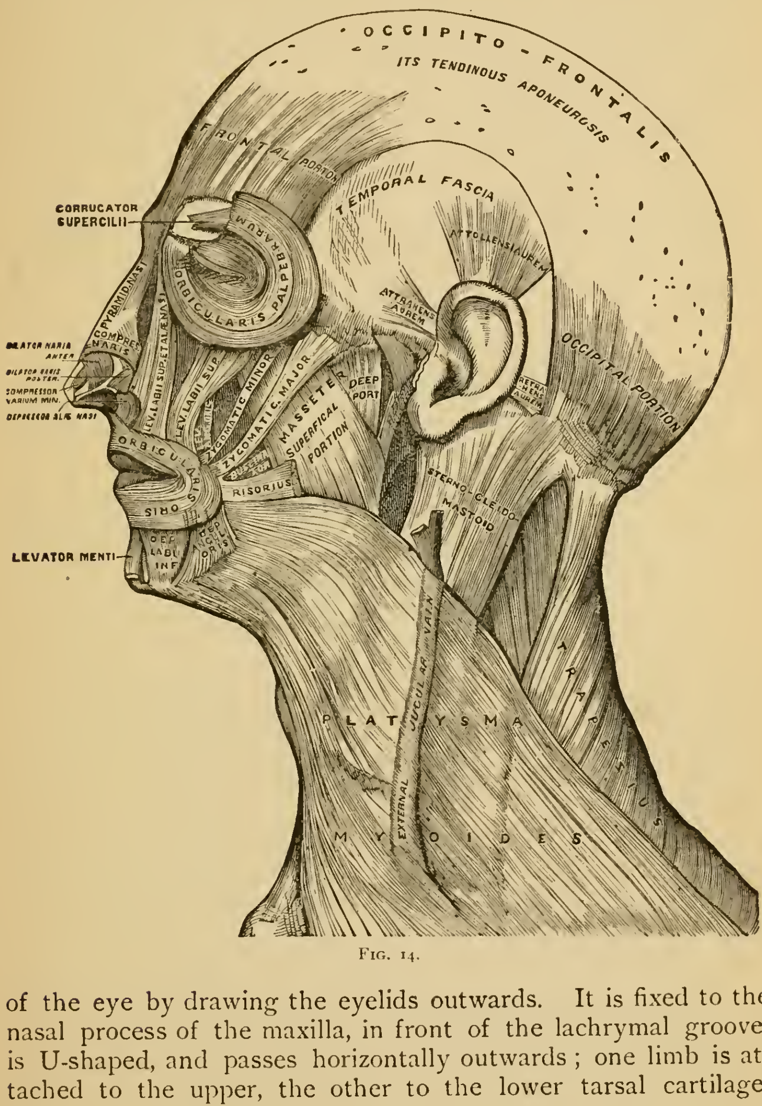


Fig. 14.

of the eye by drawing the eyelids outwards. It is fixed to the nasal process of the maxilla, in front of the lachrymal groove, is U-shaped, and passes horizontally outwards; one limb is attached to the upper, the other to the lower tarsal cartilage.

The tendon crosses the lachrymal sac a little above the centre, and furnishes a tendinous expansion which covers the sac and is attached to the margin of the bony groove which contains it. To see this expansion we must reflect that portion of the orbicularis palpebrarum which covers the sac.

In puncturing the lachrymal sac the knife is introduced below the tendon, in a direction downwards, outwards, and a little backwards. We have to divide the skin, a few fibres of the orbicularis, and the fibrous expansion from the tendo palpebrarum. The angular artery and vein are situated on the inner side of the incision.

Orbicularis Palpebrarum. — This thin, broad muscle surrounds the margin of the orbit and the eyelids, forming a sphincter. It is attached on the inner side to the tendo palpebrarum, to

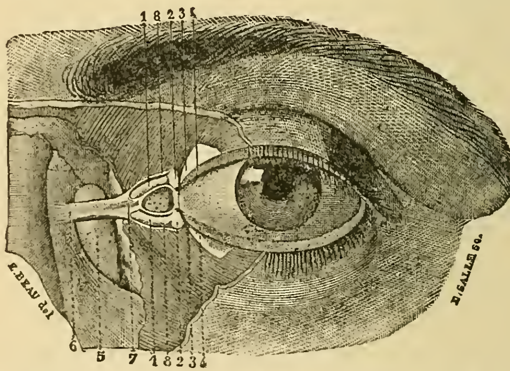


FIG. 15. — TENDON OF THE ORBICULARIS PALPEBRARUM, SHOWING THE UNION OF THIS TENDON WITH THE LACHRYMAL SAC AND THE LACHRYMAL CANALS. (*Sappey.*)

1. Lachrymal canals. 2, 2. Commencement of these canals in the lids. 3, 3. Internal extremity of the tarsal cartilages. 4, 4. Free border of the lids. 5. Lachrymal sac. 6. Attachment of the tendo oculi to the nasal process of the maxilla. 7. The division of the tendo oculi into its two branches. 8, 8. The two branches ensheathing the two lachrymal canals and attached to the internal extremity of the tarsal cartilages.

the nasal process of the maxilla, to the internal angular process of the frontal bone, and to the lower margin of the orbit. From this attachment the fibres form a series of oval curves, taking a wide sweep, and pass uninterruptedly round the eyelids and orbit.

The fibres which belong to the eyelids (*palpebral portion*) are thin and pale, and form, over each eyelid, a series of elliptical curves which meet at the external canthus of the lids, and are loosely attached to the external tarsal ligament. The degree of their curvature becomes less as they approach the margin of the lids, so that some fibres proceed close to the lashes.

This was first pointed out by Riolanus,* and described as the *musculus ciliaris*.†

The fibres which spread over the orbital margins (*orbital portion*) are thicker and redder, and mingle, on the forehead, with the occipito-frontalis and corrugator supercilii, on the cheek, with the elevators of the upper lip and nose and the zygomaticus minor.

No fat is found on the eyelids ; nothing intervenes between the skin and the muscles but loose connective tissue, that there may be no impediment to the free play of the lids.

The orbicular muscle not only closes the eyelids but protects the eye. When the eye is threatened, the muscle suddenly contracts, presses the eye back into the orbit, and contracts the skin of the brow and cheek so as to form a soft cushion in front of it. The cushion itself may be severely bruised, as is seen in a "black eye ;" but the globe itself is rarely injured. When the eye is closed, as in winking, the palpebral portion of the muscle contracts. Observe this movement, and notice that the lids are drawn slightly inwards as well as closed. The object of this inward motion is to direct the tears towards the inner angle of the eyelids, where they are absorbed by the puncta lachrymalia.

The tensor tarsi muscle is described in the dissection of the orbit.

Since the orbicular muscle is supplied by the facial nerve, it is affected in facial palsy, and the patient cannot close the lids.

Corrugator Supercilii. — This *arises* from the inner end of the superciliary ridge of the frontal bone, and is *inserted* into the under surface of the orbicularis palpebrarum and occipito-frontalis. It lies concealed beneath these two muscles, and is the proper muscle of frowning. Its nerve is derived from the facial.

The present being a good opportunity to examine the appendages (*tutamina oculi*) of the eyes, postpone for the present the dissection of the remaining muscles of the face.

The Eyelids. — The *eyelids* are two movable elliptical folds consisting of strata of different tissues. The *upper lid* is large and more movable than the *lower*, so that when the eye is

* *Anthropologia*, lib. v., cap. 10.

† Strictly speaking, the musculus ciliaris arises from the two little divisions of the tendo oculi, and is inserted at the external canthus, into the fibrous tissue which unites the two tarsal cartilages.

closed, it is mainly by this fold. The interval between the two lids is called the *fissura palpebrarum*, which terminates on the inner and outer sides in two angles, the *canthi*. The lids are thickest at their borders, are somewhat curved, and near the inner canthus each presents a slight elevation, the *papilla lachrymalis*, at the top of which is a small opening, the *punctum lachrymale*; this is the commencement of a small canal, *canaliculus*, which receives the tears and conveys them to the lachrymal sac, and thence through the nasal duct to the nose. At the inner canthus the two lids are separated by an oval space, the *lacus lachrymalis*, where the mucous membrane is raised into a rounded eminence, the *caruncula*.

Caruncula Lachrymalis.—The *caruncula lachrymalis* is the red rounded eminence situated at the inner canthus and formed by the conjunctiva. It is composed of an aggregation of sebaceous and sweat glands covered by mucous membrane; on the surface of it are minute hairs.

Resting upon the eyeball external to the caruncle is a slight vertical triangular fold of conjunctiva, *plica semilunaris*, which is the rudimentary membrana nictitans (the third eyelid found in birds). Both in the caruncle and plica semilunaris unstriped muscular tissue has been demonstrated.

The *conjunctiva* is the mucous membrane which covers the inner surface of the lids and the front of the eyeball. The portion lining the lids is termed the *palpebral*; that portion covering the front of the eye, the *ocular*. The angle of its reflection from the lids to eyeball is called the *fornix conjunctivæ*, where are situated a number of racemose glands; there is also some lymphoid tissue found in other parts of the conjunctiva. The palpebral conjunctiva is more vascular than the ocular, and it presents a number of minute papillæ, which, when enlarged and aggregated by inflammation, give rise to the disease called "granular lids." The conjunctiva will be more fully described with the anatomy of the eye.

The *eyelashes* (cilia) are placed in two or more rows along the edges of the tarsal cartilages. The eyelashes of the upper lid are longer and more numerous than in the lower; and their convexity is directed downwards, while those of the lower lid present an opposite curve. The bulbs of the lashes are situated between the tarsal cartilage and the fibres of the orbicularis palpebrarum. They are supplied with blood by the palpebral branches of the ophthalmic artery, which run parallel and close to the free borders of the lids beneath the orbicular muscle.

Structure of the Eyelids. — The *eyelids* are composed of different tissues, arranged in successive strata one beneath the other. They are — 1. The *skin;* 2. The *orbicularis palpebrarum;* 3. The *palpebral ligament,* which extends from the margin of the orbit to the cartilage; 4. The expanded *tendon of the levator palpebræ* (in the upper lid only); 5. The *tarsal cartilage;* 6. A thin *layer of fascia,* in which are seen the blood-vessels; 7. The *Meibomian glands,* which lie embedded in the tarsal cartilage; 8. *Conjunctiva.* These structures are severally connected by areolar tissue, which never contains fat.

Such, in outline, is the structure of the eyelids. Their use is best described by Socrates, who, in answer to the question whether animals were made by chance or design, replies: "Think you not that it looks like the work of *forethought,* because the sight is delicate, to guard it with eyelids as with shutters, which open when we want to see, and shut during sleep; and, that even winds may not hurt them, to make eyelashes in the lids for a sieve; and to furnish the parts over the eyes with eyebrows, as with eaves, so that even the sweat from off the head may do them no mischief?" *

The *skin* of the eyelids is remarkably smooth and delicate, and destitute of fat. It is abundantly supplied with sensory nerves by branches of the fifth pair — namely, by the supra-orbital, supra-trochlear, infra-trochlear, lachrymal, and infra-orbital nerves.

The *orbicularis palpebrarum* has been already described (p. 44). It is supplied by the facial nerve.

The *levator palpebræ* arises from the lesser wing of the sphenoid above the optic foramen, gradually becomes broader, and terminates in a thin aponeurosis, which unites with the broad tarsal ligament, and is lost on the upper surface of the superior tarsal cartilage.

Tarsal Cartilages and Ligaments. — These are plates of dense connective tissue, which support and give shape to the eyelids. There is one for each lid, and they are connected at the angles (*commissures* or *canthi*) of the lids through the medium of fibrous tissue. They can best be examined by everting the lids. Each cartilage resembles its lid in form. The upper is the larger, is broad in the middle, and gradually becomes narrower at either end. The lower is nearly of uniform breadth throughout. Both

* Xenophon's *Memorabilia*, b. 1, c. vi., § 6.

are thicker on the nasal than on the temporal side. They are connected to the margin of the orbit, and maintained in position by the *broad tarsal* or *palpebral ligament;* this is a continuation from the periosteum of the orbit to the tarsal cartilage, and is denser at the outer part of the orbit. There are two of them — upper and lower — and they pass to each cartilage respectively. When an abscess forms in the connective tissue of the lids, these ligaments prevent the matter from making its way into the orbit.

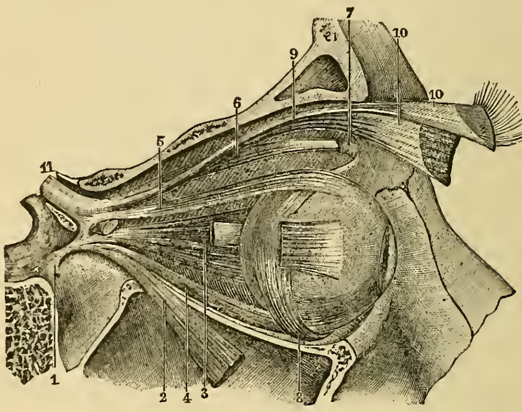


FIG. 16. — MUSCLES OF THE EYE. LIGAMENT OF ZINN.

1. Attachment of the ligament of Zinn — showing the three tongue-like projections, from its annular parts surrounding the optic nerve, to the internal, external, and inferior recti muscles. 2. External rectus, incised and deflected downwards to show the internal rectus. 3. Internal rectus. 4. Inferior rectus. 5. Superior rectus. 6. Superior oblique. 7. Pulley for the superior oblique muscle. 8. Inferior oblique. 9. Levator palpebræ. 10. Portion of the orbicularis palpebrarum. 11. Optic nerve.

Each tarsal cartilage is attached on its outer side to the malar bone by the external tarsal ligament, and on its side to the nasal process of the maxilla by the tendo palpebrarum or the internal tarsal ligament.

The free or ciliary margin is straight, and is the thickest part of the tarsal cartilages. It is generally stated that the inner edge of each is sloped or bevelled off; and that, when the lids are closed, there is formed, with the globe of the eye, a triangular channel. This channel is said to conduct the tears to the puncta lachrymalia. According to our observation, this channel does not exist; for when the lids are closed, their margins are in such accurate apposition, that not the slightest interspace can be discovered between them.

Puncta Lachrymalia. — The *puncta lachrymalia* are two pin-hole apertures, easily discovered on the margin of the lids, close to the inner angle. They are the orifices of the canals,

called *canaliculi*, which pass inwards and convey the tears into the lachrymal sac.

Observe that their orifices are directed backwards. The upper canaliculus, the longer and narrower of the two, ascends for a short distance nearly vertically, and then dilating into a small pouch makes a sharp bend inwards for about a quarter of an inch to join the lachrymal sac; the lower canal descends perpendicularly, and, like the upper, makes a sharp bend, after which it pursues a direction upwards and inwards to the sac.

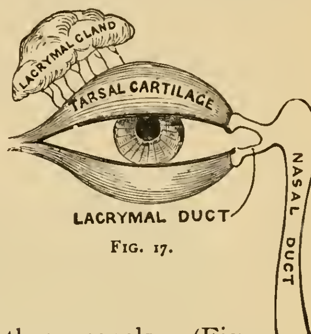


FIG. 17.

The two canals open separately into the sac (sometimes by a common orifice). In facial palsy, the tensor tarsi being affected, the puncta lose their proper direction, and the tears flow over the cheek.

In the introduction of probes for the purpose of opening the contracted puncta, or of slitting up the lachrymal ducts, it is necessary to know the exact direction of these canals. (Fig. 17.) When from any cause the tears are secreted in greater quantity than usual, they overflow and trickle down the cheek.

Meibomian Glands. — These long compound sebaceous glands, so called after the anatomist * who first described them, are situated on the under surface of each of the tarsal cartilages. In the upper lid there are between twenty and thirty; not quite so many in the lower. On everting the lid, they are seen running in longitudinal parallel rows in grooves in the cartilage. Under the microscope, each is seen to consist of a straight central tube, round the sides of which are a number of openings leading to short cæcal dilatations. The orifices of these glands are situated on the free margin of the lids behind the lashes. They are lined with flattened epithelial cells which, in the cæcal dilatations and ducts, become cubical and filled with fat. Their function is to secret a sebaceous material, which prevents the lids from sticking together.

Tensor Tarsi. — This muscle is only a deeper part of the orbicularis palpebrarum, and lies just behind the tendo palpebrarum. To expose it, cut perpendicularly through the middle of the upper and lower lids, and turn the inner halves towards the nose. After removing the mucous membrane, the muscle will be seen *arising* from the ridge of the lachrymal bone. It passes nearly horizontally outwards for about 6.5 mm., or $\frac{1}{4}$ inch, and then divides into two portions, which are *inserted* into the upper and lower tarsal cartilages, close to the orifices of the lachrymal ducts. It is probable that the tensor tarsi draws backwards the open mouths of the ducts, so that they may receive the

* H. Meibom.

tears at the inner angle of the eye. It is supplied by a small branch from the facial nerve.

Let us now examine the muscles in connection with the nose: namely — the pyramidalis nasi, the compressor naris, the depressor alæ nasi, and the smaller intrinsic muscles of the nose. All are supplied by the facial nerve.

Pyramidalis Nasi.— This is situated on the bridge of the nose, one on each side of the mesial line, and is usually regarded as a continuation of the inner part of the occipito frontalis. The two muscles diverge as they descend, and their fibres blend with

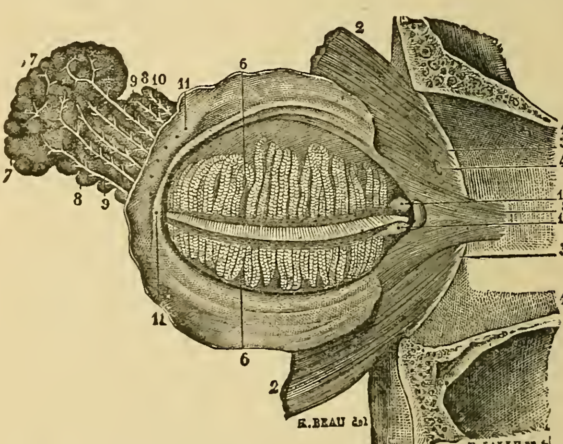


FIG. 18.— TENSOR TARSI-ATTACHMENT OF THE ORBICULARIS PALPEBRARUM TO THE INNER PART OF THE BASE OF THE ORBIT. (*Sappey.*)

1, 1. Inner wall of the orbit. 2, 2. Internal part of the orbicularis palpebrarum. 3, 3. Attachment of this muscle to the circumference of the base of the orbit. 4. Opening for the nasal artery. 5. Tensor Tarsi. 6, 6. Posterior view of the lids. 7, 7. Orbital portion of the lachrymal gland. 8, 9, 10. Palpebral portion of this gland. 11, 11. Mouths of its excretory ducts.

those of the compressor naris. Their action produces transverse wrinkles of the skin at the root of the nose, as in the expression of an aggressive feeling.

Compressor Naris. — This muscle is triangular, and *arises* by its apex from the inner side of the canine fossa of the maxilla, and is *attached* to a broad thin aponeurosis which spreads over the dorsum of the nose, and joins its fellow. The origin of this muscle is concealed by the levator labii superioris alæque nasi.

When this muscle is reflected from its junction with its fellow, a small nerve is seen running down towards the tip of the nose. This nerve is the *superficial branch* of the nasal nerve

(called also *naso-lobular*). It becomes subcutaneous between the nasal bone and the cartilage, and supplies the tip and lobule of the nose. It is joined by a branch of the facial nerve at its termination.

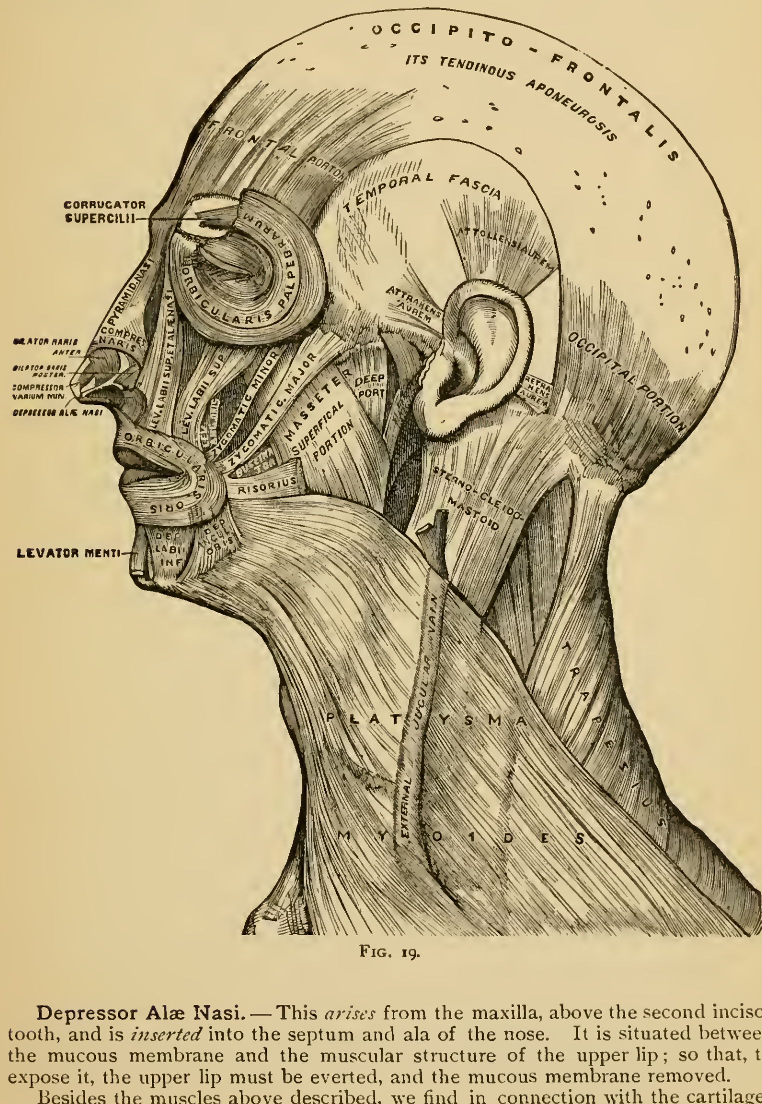


FIG. 19.

Depressor Alæ Nasi.—This *arises* from the maxilla, above the second incisor tooth, and is *inserted* into the septum and ala of the nose. It is situated between the mucous membrane and the muscular structure of the upper lip; so that, to expose it, the upper lip must be everted, and the mucous membrane removed.

Besides the muscles above described, we find in connection with the cartilages

of the alæ of the nose, pale muscular fibres which have no very definite arrangement and require a lens for their detection. The *dilatator naris posterior* arises from the nasal process of the maxilla and the sesamoid cartilages, and is inserted into the skin of the margin of the nostril; the *dilatator naris anterior* descends vertically from the cartilage of the aperture to its free margin. The action of these small muscles is to raise and evert the ala of the nose, and to counteract its tendency to be closed by atmospheric pressure. In dyspnœa, and in certain mental emotions, they contract with great energy.

Levator Labii Superioris Alæque Nasi, or Levator Labii Superioris et Alæ Nasi. — This *arises* from the nasal process of the maxilla near its orbital margin, and passing downwards divides into two portions: an inner *inserted* into the side of the ala of the nose; an outer, into the upper lip, where its fibres blend with the orbicularis oris and levator labii superioris. It acts chiefly in expressing the smile of derision. Its habitual use occasions the deep furrow which, in most faces, runs from the ala of the nose towards the corner of the mouth.

Levator Labii Superioris Proprius.—This *arises* from the lower margin of the orbit, *i.e.*, from the maxilla and malar bones, above the infra-orbital foramen, and is *inserted* into the upper lip, where its fibres blend with the orbicularis oris. It is nearly an inch in breadth at its origin, which covers the infra-orbital vessels and nerves, and is itself overlapped by the orbicularis palpebrarum.

Levator Anguli Oris. — This muscle, which is covered by the levator labii superioris, *arises* from the canine fossa of the maxilla, below the infra-orbital foramen, and is *inserted* into the angle of the mouth, superficial to the buccinator, its fibres blending with those of the orbicularis oris, the zygomatici, and the depressor anguli oris.

Buccinator. — The buccinator *arises* from the outer surface of the alveolar borders of the maxilla and mandible corresponding to the molar teeth, and behind from the pterygo-mandibular ligament. The fibres pass forwards and converge, to be inserted into the angle of the mouth and the muscular structure of the lips; the central fibres decussate, while the upper fibres pass to the upper lip, and the lower fibres pass to the lower lip. The muscle is covered on its inner aspect by the mucous membrane of the cheek, and on its outer by a thin fascia which passes backwards, and is continuous with that covering the pharynx.

The buccinator is the principal muscle of the cheek. It forms with the superior constrictor of the pharynx a continuous muscular wall for the side of the mouth and pharynx. The bond of

connection between the buccinator and the superior constrictor is a tendinous band, the *pterygo-mandibular ligament.* This ligament (Fig. 20) extends from the hamular process vertically to the posterior extremity of the mylo-hyoid ridge of the mandible near the last molar tooth. It is simply a fibrous intersection between the two muscles.

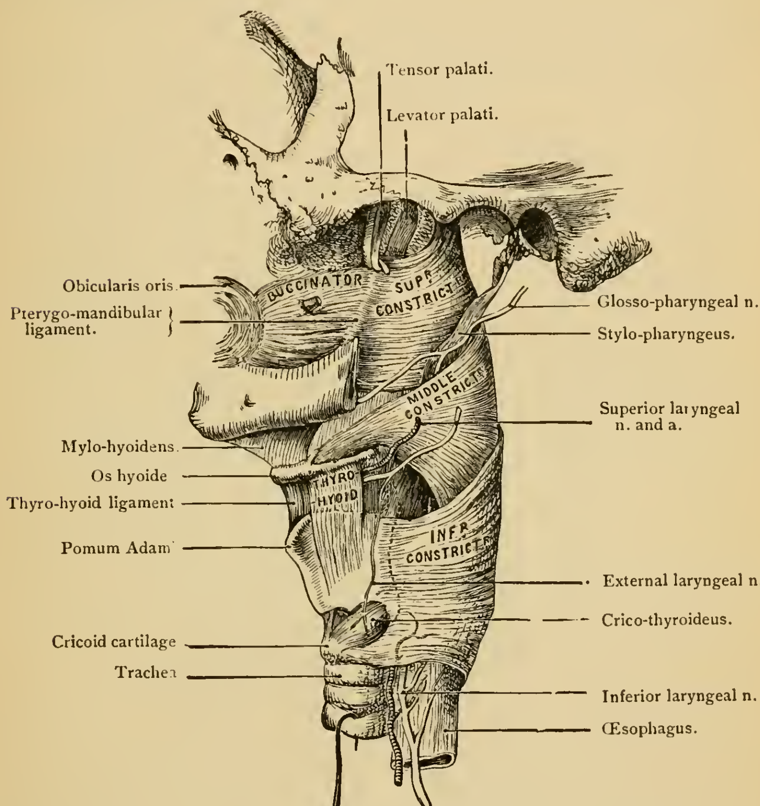


FIG. 20.— MUSCLES OF THE PHARYNX.

The duct of the parotid gland pierces the buccinator obliquely, and opens into the mouth opposite the second molar tooth of the maxilla.

The chief use of the buccinator is to keep the food between the teeth during mastication. It can also widen the mouth. Its power of expelling air from the mouth, as in whistling or playing

on a wind instrument, has given rise to its peculiar name. It is supplied by the facial nerve, and is, therefore, affected in facial paralysis.

The buccinator is in relation, externally and behind, with a large amount of buccal fat, with the masseter and temporal muscles; in front with the risorius, the levator anguli oris, depressor anguli oris, the zygomatici, the duct of the parotid gland, the facial artery and vein, and the facial and buccal nerves; internally with the mucous membrane of the mouth and buccal glands; and posteriorly with the pterygo-mandibular ligament.

Buccal Fascia. — The buccinator muscle is covered by a thin layer of fascia which adheres closely to its surface, and is attached to the alveolar border of the maxilla and mandible. This structure is thin over the anterior part of the muscle, but more dense behind, where it is continuous with the aponeurosis of the pharynx. It is called the *bucco-pharyngeal fascia*, since it supports and strengthens the muscular walls of these cavities. In consequence of the density of this fascia, abscesses do not readily burst into the mouth of the pharynx.

Buccal and Molar Glands. — The *buccal* glands, in structure compound racemose like the salivary, are situated between the buccinator and the mucous membrane. They resemble the labial glands found beneath the mucous membrane of the lips. though somewhat smaller. Three or four other glands, about the size of a little split pea, should be made out, as they lie between the masseter and buccinator; these are the *molar* glands. Their secretion, said to be mucous, is conveyed to the mouth by separate ducts near the last molar teeth.

Between the buccinator and the masseter, there is, in almost all subjects, an accumulation of fat. It is found, beneath the zygoma especially, in large round masses, and may be turned out with the handle of the scalpel. It helps to fill up the zygomatic fossa, and being soft and elastic, presents no obstacle to the free movements of the mandible. Its absorption in emaciated individuals occasions the sinking of the cheek.

Facial Artery. — The *facial* (external maxillary) artery is the third branch of the external carotid. It ascends tortuously beneath the posterior belly of the diagastricus and the stylohyoideus, next *through* or under the substance of the submandibular gland; it then rests upon the mylo-hyoideus, and subsequently mounts over the base of the mandible at the *anterior edge of the masseter* muscle. This part of the course of the facial will be fully examined further on in the dissection of the neck. It now ascends tortuously near the corner of the mouth and the ala of the nose, towards the inner angle of the eye, where, much diminished in size, it inosculates with the terminal branch of the ophthalmic, a branch of the internal carotid.

In the first part of its course on the face, the artery is covered by the platysma and the deep fascia; above the corner of the mouth it is crossed by a few fibres of the risorius and the zygomatici; still higher it is covered by some of the fibres of the elevator of the upper lip.* It lies successively upon the buccinator, levator anguli oris, and levator labii superioris alæque nasi

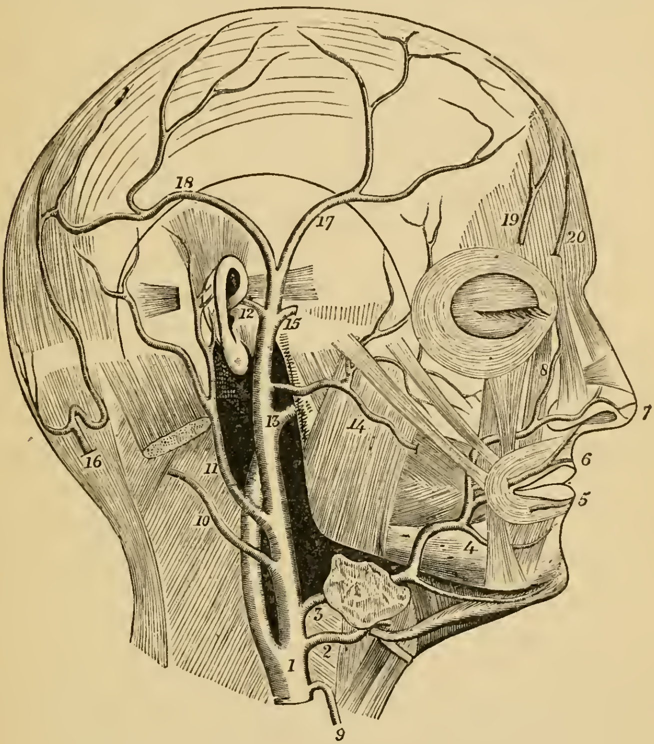


FIG. 21. — BRANCHES OF THE EXTERNAL CAROTID ARTERY.

1. External carotid. 2 Lingual. 3. Facial. 4. Inferior labial. 5. Inferior coronary. 6. Superior coronary. 7. Lateral nasal. 8. Angular. 9. Superior thyroid. 10 and 16. Occipital. 11. Posterior auricular. 12. Anterior auricular. 13. Internal maxillary. 14. Transverse facial. 15. Middle temporal. 17. Anterior temporal. 18. Posterior temporal. 19. Supraorbital. 20. Frontal.

muscles. In its course along the face it gives off the following branches: —

a. The **inferior labial** artery passes inwards under the depressor anguli oris and inosculates with the mental branch of the inferior dental, the inferior coronary, and the submental arteries.

* Not infrequently the artery lies superficial to this muscle.

b. The inferior coronary artery comes off near the angle of the mouth, either directly from the facial, or in common with the superior coronary. It runs tortuously along the lower lip, beneath the depressor anguli oris; it then pierces the orbicularis, running between this muscle and the mucous membrane of the lip. It inosculates largely with its fellow, the inferior labial and the mental arteries.

c. The superior coronary, larger than the preceding, is given off beneath the zygomatici. It proceeds along the upper lip close to the mucous membrane, and inosculates with its fellow; thus is formed round the mouth a complete arterial circle, which can be felt pulsating on the inner side of the lip, near the free border. From this circle numerous branches pass off to the papillæ of the lips and the labial glands. The superior coronary gives off a branch, *the artery of the septum*, which ascends along the septum to the apex of the nose; also a small one to the ala nasi.

d. The lateral artery of the nose, a branch of considerable size, arises opposite the ala nasi, ramifies upon the external surface of the nose, and inosculates with the nasal branch of the ophthalmic artery, the infra orbital, and the artery of the septum.

e. The angular artery, which may be regarded as the termination of the facial, inosculates on the inner side of the tendo-palpebrarum with the nasal branch of the ophthalmic artery.

The facial artery supplies numerous branches to the muscles of the face, and inosculates with the transversalis faciei, infra-orbital, the mental, the sublingual branch of the lingual, the nasal branches of the internal maxillary and the ophthalmic, the ascending pharyngeal and descending palatine arteries.

The facial artery and its branches are surrounded by a minute plexus of nerves (nervi molles) invisible to the naked eye. They are derived from the superior cervical ganglion of the sympathetic, and exert a powerful influence over the contraction and dilatation of the capillary vessels, and thus occasion those sudden changes in the countenance indicative of certain mental emotions, *e.g.*, blushing or sudden paleness.

The facial vein does not run with the artery, but takes a straight course from the inner angle of the eye to the anterior border of the masseter. In this course it descends upon the levator labii superioris, then passes beneath the zygomatic muscles, over the termination of the parotid duct, and at the anterior border of the masseter passes over the mandible, behind the facial artery, and joins the internal jugular.

The facial vein is a continuation of the frontal, which descends over the forehead, and, after receiving the supra-orbital, takes the name of *angular* at the corner of the eye. It communicates with the ophthalmic vein, receives the veins of the eyelids, the external part of the nose, the coronary veins, and others from the muscles of the face. Near the angle of the mouth it is increased in size by a communicating branch from the infra-orbital vein, and by a large vein which comes from the temporo-mandibular vein. The other veins which empty themselves into the facial correspond with the branches given off from the facial artery.

Arteria transversalis faciei. — This artery arises from the temporal, or occasionally from the external carotid in the substance of the parotid gland. It runs forwards across the masseter between the parotid duct and the zygoma, and is distributed to the glandula socia parotidis, and the masseter. It anastomoses with the infra-orbital, buccal, and facial. It is seldom of large size, except when it supplies those parts which usually receive blood from the facial. We have seen it as large as a goose-quill, furnishing the coronary and the nasal arteries, the facial itself not being larger than a sewing-thread.

The parotid gland is now to be examined. Its boundaries, its deep relations, the course of its duct, and the objects contained within the gland, must be carefully observed.

Parotid Gland. — The parotid, the largest of the salivary glands, occupies the space between the ramus of the mandible and the mastoid process, and weighs between five and eight drachms (20 to 32 gm.). It is bounded above by the zygoma; below, by the sterno-mastoid and digastric muscles; behind, by the meatus auditorius externus and the mastoid process; in front, it lies over the ascending ramus of the mandible, and is prolonged for some distance over the masseter. Internally it is in contact with the styloid process, and the sheath of the internal carotid and jugular vein. It is separated from the submandibular gland by the stylo-mandibular ligament; sometimes the two glands are directly contiguous.

The superficial surface of the gland is flat, and covered by a strong layer of fascia, a continuation of the cervical, and has one or two lymphatic glands lying on it.

It not only surrounds the gland, but sends down numerous partitions which form a framework for its lobes. The density of this sheath explains the pain caused by inflammation of the gland, the tardiness with which abscesses within it make their way to the surface, and the propriety of an early opening. [The only open space in its capsule being at the styloid process, an abscess may ascend into the temporal fossa or go into the retro-pharyngeal region. — A. H.]

The deep surface of the gland is irregular, and moulded upon the subjacent parts.

Thus it sends a prolongation which passes inwards between the neck of the mandible and the internal lateral ligament; another process which passes in front of the styloid process, and extends upwards and occupies the posterior part of the glenoid cavity; a third process passes behind the styloid process, below the mastoid process and behind the sterno-mastoid muscle, and sometimes penetrates deep enough to be in contact with the internal jugular vein.

The internal carotid artery and internal jugular vein are in contact with the gland internally.

On carefully removing the substance of the parotid gland, the following structures are seen in its interior, proceeding in the order of their depth from the surface:—

1. Two or more small lymphatic glands.

2. The pes anserinus, or primary branches of the facial nerve, which emerges at its anterior border.

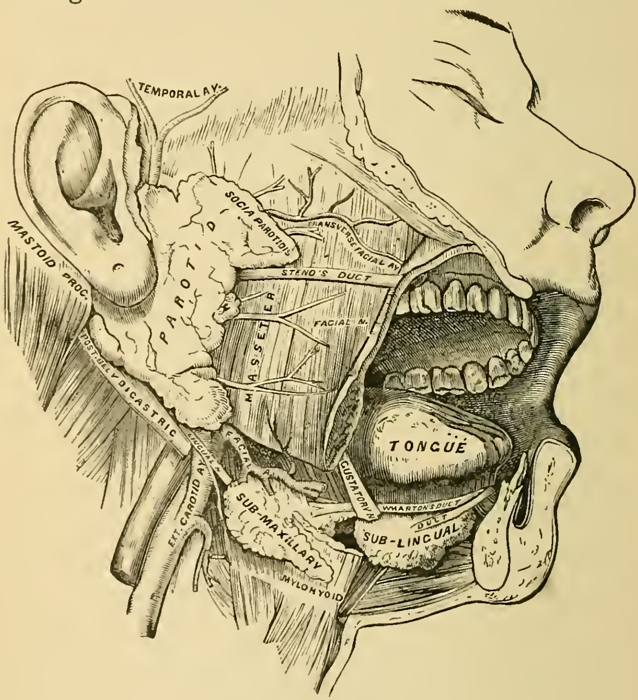


FIG. 22.

3. Branches from the great auricular and auriculo-temporal nerves which communicate in its substance with the facial nerve.

4. The external jugular vein formed by the junction of the internal maxillary and temporal veins.

5. The external carotid artery, which, after distributing many branches to the gland, divides, opposite the neck of the mandible, into the internal maxillary and temporal, the latter giving off in the gland the posterior auricular and transverse facial arteries.

That portion of the gland which lies on the masseter muscle is called *glandula socia parotidis.* It varies in size in different subjects; and is situated chiefly above the parotid duct, into which it pours its secretion by one or two smaller ducts.

The *duct* of the parotid gland (ductus Stenonis *), about two inches and a half (*6.5 c. m.*) long, 3 mm. in diameter, is very thick and strong. In this respect it differs from the duct of the submandibular gland, which is less exposed to injury. The volume of the parotid is 26 c. cm., its weight is 6.75 drachms (27 gm.). It runs transversely forwards over the masseter, about an inch (*2.5 c. m.*) below the zygoma, through the fat of the cheek, then perforates the buccinator obliquely, and opens into the mouth opposite the second molar tooth of the maxilla. Near its termination it is crossed by the zygomaticus major and the facial vein. After perforating the buccinator, the duct passes for a short distance between the muscle and the mucous membrane. Its orifice is small and contracted compared with the diameter of the rest of the duct, which will admit a crow-quill; it is not easily found in the mouth, being concealed by a fold of mucous membrane.

The direction of the parotid duct ccrresponds with a line drawn from the middle of the lobule of the ear to a point midway between the nose and the mouth.

The blood supply of the parotid is derived from the external carotid and its branches, which are accompanied by their respective veins. Its nerves are supplied from the sympathetic plexus, around the external carotid, the auriculo-temporal, the great auricular, and the facial nerves.

The *lymphatic* glands about the parotid deserve notice, since they are liable to become enlarged, and simulate disease of the parotid itself. A lymphatic gland lies close to the root of the zygoma, in front of the cartilage of the ear; this gland is sometimes affected in disease of the external tunics of the eye; *e.g.*, in purulent ophthalmia; also in affections of the scalp.

To display the plexus of nerves (pes anserinus), formed by the branches of the facial, cut into the parotid gland by a vertical incision until the main trunk of the nerve is reached.

Portio dura, or Facial Nerve. — This is the seventh cranial nerve, and is the motor nerve of the face. It supplies all the muscles of expression, the platysma, and the buccinator. Through some of its branches it supplies other muscles, the description of which will be deferred till the facial nerve is dissected in the temporal bone.

* Nic. Steno, *De Glandulis Oris, etc.* Bat. 1661.

It arises immediately below the pons, from the lateral tract of the medulla oblongata, between the olivary and restiform bodies. The nerve enters the meatus auditorius internus, lying upon the auditory nerve, traverses a tortuous bony canal [*Aquceductus Fallopii*] in the petrous portion of the temporal bone, and leaves the skull at the stylo-mastoid foramen. Its course and connections in the temporal bone will be studied hereafter: at present we must trace the facial part of the nerve.

Having emerged from the stylo-mastoid foramen, the nerve enters the parotid gland, and divides behind the ramus of the mandible into two primary branches, named, from their distribution, *temporo-facial* and *cervico-facial.* These primary branches cross over the external carotid artery and the external jugular vein, and form, by their communications within the substance of the parotid, the plexus called *pes anserinus,* from its fancied resemblance to the skeleton of a goose's foot (Fig. 23).

Close to the stylo-mastoid foramen, the facial nerve gives off its **posterior auricular** branch (Fig. 23), which ascends behind the ear and divides into two, an *auricular* and an *occipital.*

The former supplies the retrahens and attollens aurem, the latter the posterior belly of the occipito-frontalis. This branch communicates with the deep branch of the great auricular n., with the small occipital, and with the auricular branch of the pneumogastric. Its two next *branches* supply the stylo-hyoideus and the posterior belly of the digastric. The digastric nerve enters the muscle by many filaments; the nerve to the stylo-hyoideus is long, and enters the muscle about the middle. The stylo-hyoid branch communicates with the sympathetic on the external carotid a.; the digastric branch with the glosso-pharyngeal near the base of the skull. These two muscular nerves are frequently given off from a common branch.

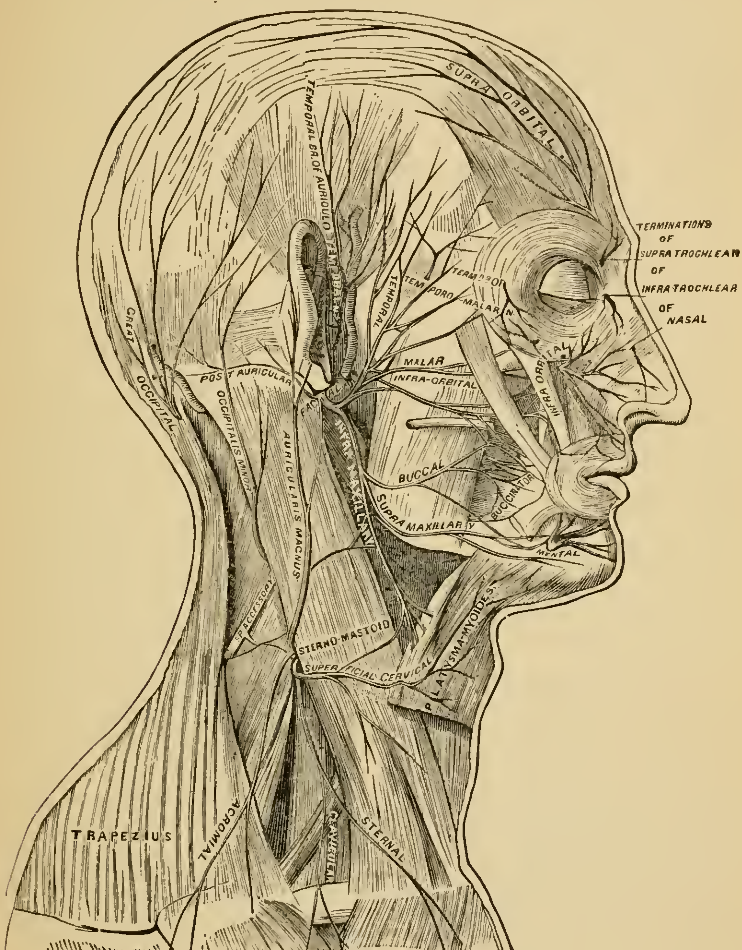
The **temporo facial** division, the larger of the two, in passing through the parotid gland, crosses the external carotid and the neck of the mandible, receives two or more communications from the auriculo-temporal (branch of the fifth), and subdivides into temporal, malar, and infra-orbital branches.

The *temporal* branches ascend over the zygoma, supply the frontalis, the attrahens aurem, the orbicularis palpebrarum, the corrugator supercilii, and tensor tarsi, and communicate with filaments of the supra-orbital nerve, with the temporal branch of the superior maxillary n. (*supra-mandibular*), with the auriculo-temporal n., and with the lachrymal n.

The *malar* branches cross the malar bone, supply the orbicular muscle, and communicate with filaments of the lachrymal, the supra-orbital, the maxillary, and the malar branch of the maxillary.

The **infra-orbital** branches are the largest, and proceed transversely forwards over the masseter beneath the zygomatici, to supply the orbicularis oris, the elevators of the upper lip, and the muscles of the nose.

The superficial branches join with the nasal and infra-trochlear branches of the ophthalmic along the side of the nose; the deep branches communicate beneath the levator labii superioris with the infra-orbital branches of the maxillary nerve forming the *infra-orbital plexus*, and also with the buccal branches of the facial.



The cervico facial division, joined in the parotid gland by filament from the great auricular (branch of the cervical plexus), descends towards the angle of the mandible, and subdivides into buccal, supra- and infra-maxillary branches.

The *buccal* branches pass forwards over the masseter parallel with the parotid duct, and supply the buccinator; they communicate with the buccal branch of the inferior maxillary nerve (third division of the fifth), and with the infra-orbital nerve.

The *supra-maxillary* (*supra-mandibular*) branches advance over the masseter and facial artery, and run under the platysma and the depressor muscles of the lower lip, all of which they supply. Some of the filaments communicate with the mental branch of the inferior dental nerve.

The *infra maxillary* (*infra-mandibular*) or cervical branches, one or more in number, arch forwards below the mandible covered by the platysma, as low as the hyoid bone, and communicate with the superficial cervical (branch of the cervical plexus).

Sensory Nerves of the Face. — These are the supra-orbital, the supra- and infra-trochlear, the naso-lobular, the temporo-malar, the infra-orbital, and the mental, all branches of the fifth pair.

The *supra-orbital nerve* is the continuation of the frontal, which is a branch of the first division of the fifth pair. It leaves the orbit through the supra-orbital notch and ascends upon the forehead, at first covered by the orbicularis and occipito-frontalis. It presently divides into two sets of branches — an *outer*, the larger, which passes backwards as far as the occipital bone, and an *inner*, which ascends as far as the parietal bone. It distributes sensory muscular branches also to the orbicularis palpebrarum, corrugator supercilii, the occipito-frontalis, to the pericranium, and branches which supply the skin of the forehead, upper eyelid, and scalp. It communicates with the facial nerve on the forehead. The supra-orbital artery is a branch of the ophthalmic.

The *supra-trochlear n.*, or internal frontal, appears at the inner angle of the orbit between the supra-orbital foramen and the pulley of the superior oblique, and sends down in front of the pulley a loop to communicate with the infra-trochlear branch of the nasal. The main trunk of the nerve ascends to the forehead. Its further course has been described (p. 23).

The *infra-trochlear n.* issues from the orbit below the pulley, and supplies branches to the eyelids, the conjunctiva, lachrymal sac, and the side of the nose.

The *infra-orbital nerve* is the terminal branch of the maxillary or second division of the fifth nerve. It emerges with its artery from the infra-orbital foramen, covered by the levator labii superioris.

The nerve immediately divides into several branches, *palpebral*, *nasal*, and *labial;* the palpebral, ascending beneath the orbicularis, supply the lower eyelid, and communicate with the facial and the malar branch of the orbital nerve; the nasal pass inwards to supply the nose, and join the nasal branch (naso-lobular) of the ophthalmic; the labial, by far the most numerous, descend into the upper lip, beneath the levator labii superioris, and eventually terminate in lashes of filaments, which endow the papillæ of the lip and the mucous membrane of the mouth with exquisite sensibility. Close to the infra-orbital foramen is the infra-orbital plexus, before alluded to (p. 61).

The *infra-orbital artery* is the terminal branch of the internal maxillary; it supplies the muscles, the skin, and the front teeth of the maxilla, and inosculates with the transverse facial, buccal, facial, and coronary arteries.

The *naso-lobular nerve* is the external branch of the nasal nerve, and is distributed to the tip and lobule of the nose, and is joined by filaments from the facial nerve.

The *temporal branch* of the *orbital nerve* (branch of the maxillary nerve, running along the outer wall of the orbit, and which divides into a temporal and a malar branch) issues through the temporal fascia about a finger's breadth above the zygoma, and supplies the skin of the temple. It communicates with the facial and the auriculo-temporal nerves.

The *malar nerve*, a branch also of the orbital nerve, issues through a foramen in the malar bone, and, after piercing the orbicularis palpebrarum, supplies the skin of the cheek over the malar bone. It communicates with the facial and the palpebral branches of the infra-orbital nerve.

The *mental nerve* is a branch of the mandibular or third division of the fifth. It emerges from the mental foramen in the mandible, in a direction upwards and backwards, beneath the depressor anguli oris. It soon divides into a number of branches beneath the depressor labii inferioris, some of which supply the skin of the chin, but the greater number terminate in the papillæ of the lower lip. It communicates with the facial nerve.

FIG. 24.—DIAGRAM OF THE SENSORY NERVES OF THE SCALP AND FACE.

1. Great occipital. 2. Small occipital. 3. Auricular br. of the pneumogastric. 4. Great auricular. 5. Auriculo-temporal. 6. Temporal br. of maxillary nerve. 7. Supra-orbital. 8. Supra-trochlear. 9. Malar br. of maxillary nerve. 10. Infra-trochlear. 11. Naso-lobular. 12. Infra-orbital. 13. Buccal br. of nerve. 14. Mental.

The *mental artery* is a branch of the mandibular. It supplies the gums and the chin, and inosculates with the submental, the inferior labial, and inferior coronary arteries.

Dissection.—To expose the contents of the orbit, remove that portion of the orbital plate which forms the roof of the orbit as far back as the optic foramen, making one section with a saw on the outer side, and the other on the inner side of the roof, so that the two sections converge at the optic foramen. In doing this, be careful not to injure the little pulley on the inner side of the superior oblique. If the bone be sufficiently

sawn through, a gentle tap with the saw on the front of the orbital plate will fracture its thin wall transversely. The anterior fourth of the roof should be turned forwards and downwards and kept in this position by hooks; the remainder is to be removed by bone forceps nearly as far as the optic foramen, so as to leave a ring of bone from which most of the ocular muscles have their origin. The eyeball should be made tense by blowing air through a blowpipe passed well into the globe through the cranial end of the optic nerve.

Periosteum of the Orbit. — The roof being removed, we expose the fibrous membrane which lines the walls of the orbit. It is a continuation of the dura through the sphenoidal fissure. Traced forwards, we find that it is loosely connected to the walls of the orbit, and that at the margin of the orbit it divides into two layers, one of which is continuous with the periosteum of the forehead, the other forms the broad tarsal ligament which fixes the tarsal cartilage.

The periosteum is now to be removed, and the fascia of the orbit made out. The following objects should then be carefully traced: in the middle are seen the *frontal artery and nerve*, lying on the levator palpebræ; on the outer side, the *lachrymal nerve and artery* pass forwards on the external rectus to the lachrymal gland, which lies under cover of the external angular process; on the inner side is the *fourth nerve*, lying on and supplying the superior oblique.

Fascia of the Orbit and Capsule of Tenon. — The fascia of the orbit provides the lachrymal gland and each of the muscles with a loose sheath, thin and delicate at the back of the orbit, but stronger near the eyeball. It is pierced behind by the optic nerve and by the arteries and nerves of the orbit, while in front it is connected with the ocular conjunctiva close to the cornea. The sheaths are firmly adherent to the muscles, and their tendinous insertions into the globe are connected by the fascia. From the insertions of the muscles it is reflected as a double layer backwards over the globe, so that it resembles a serous membranous sac — a tunic vaginalis — one layer being loosely connected with the globe, and extending back to the optic nerve where it is loose and saculated, the other lining the fat in which the globe is set. These layers are lined with epithelium, and internally it is connected with the sclerotic by delicate connective tissue (*Adventitia oculi* Lockwood) except around the optic nerve entrance where it blends with the sclerotic.

This reflection of the orbital fascia is called the *capsule of Tenon*, its use being to allow free movement of the globe, and the interval between the folds of the capsule is known as Tenon's space.

The orbit contains a large quantity of granular fat, which forms a soft bed for the eye, and prevents its being retracted too far by its muscles. Upon the amount of this fat depends, in some measure, the prominence of the eyes. Its absorption in disease or old age occasions the sinking of the eyeballs. [The maintenance of the eyeball is partly due to elastic ligamentous structures connecting the tendons of the internal and external recti lachrymal and malar bones, known as *check ligaments*. A. H.]

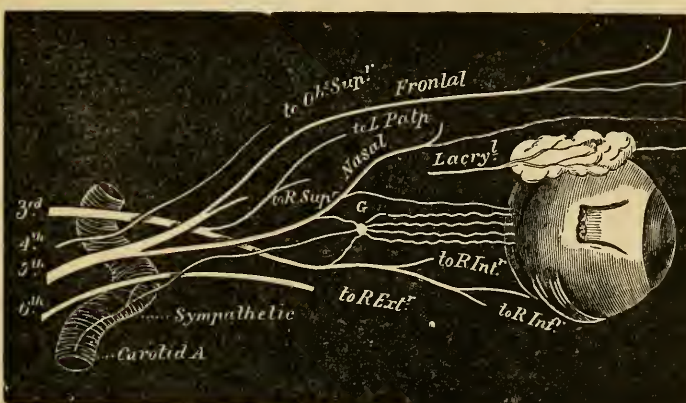


FIG. 25.—DIAGRAM OF THE NERVES OF THE ORBIT.

Contents of the Orbit.—In the middle of the orbit is the eyeball, surrounded by more or less fat, and attached to it are six muscles which move it: four, running forwards in a straight direction, are called the *recti*, and are arranged one above, one below, and one on each side of the globe; the remaining two are called, from their direction, *obliqui*, one superior, the other inferior. There is also a muscle to raise the upper eyelid, termed *levator palpebræ*. The *nerves* are: the optic, which passes through the optic foramen; the third, the fourth, the first division of the fifth, the sixth, and some filaments of the sympathetic, all of which pass through the sphenoidal fissure. The third supplies all the muscles with motor power, except the superior oblique, which is supplied by the fourth, and the external rectus, which

is supplied by the sixth. The first or ophthalmic division of the fifth divides into a frontal, lachrymal, and nasal branch. The ophthalmic artery, a branch of the internal carotid, passes into the orbit through the optic foramen ; its vein passes backwards through the sphenoidal fissure to join the cavernous sinus.

Frontal Nerve. — The *ophthalmic*, or first division of the fifth — a sensory nerve — after giving off from its inner and lower side, whilst within the cavernous sinus, the nasal nerve, divides into the frontal and lachrymal nerves, of which the former is the larger.

It is the smallest division of the fifth, and runs forwards for the distance of about an inch (2.5 c. m.) ; in its course it is connected with the cavernous plexus of the sympathetic, with the third, fourth, and sixth nerves, and close to its origin from the Gasserian ganglion it sends off a small recurrent branch to the tentorium.

One of its divisions, the frontal nerve, runs forwards upon the under surface of the levator palpebræ, on which, about midway in the orbit, it divides into two branches — the supra-trochlear and the supra-orbital.

a. The *supra-trochlear*, the smaller of the two (Fig. 26, p. 67) runs obliquely inwards above the pulley of the superior oblique to the inner angle of the orbit. Here it gives off a small communication downwards to the infra-trochlear branch of the nasal, and then divides, after passing between the bone and the orbicularis palpebrarum, into filaments which supply the skin of the upper eyelid, forehead, and nose. One or two small filaments may be traced through the bone to the mucous membrane of the frontal sinuses.

b. The *supra-orbital* is the continuation of the frontal nerve, and runs forwards on the levator palpebræ to the supra-orbital notch, through which it ascends to supply the skin of the upper eyelid, forehead, pericranium, and scalp. Its cutaneous branches, an inner and an outer, which run upwards beneath the occipito-frontalis, have been described in the dissection of the scalp (p. 23). It supplies with common sensation the orbicularis palpebrarum, the occipito-frontalis, and the corrugator supercilii, where it joins the facial nerve.

Lachrymal Nerve. — This is the smallest of the three branches of the ophthalmic nerve. It runs along the upper border of the external rectus on the outer side of the orbit with the lachrymal artery, through the lachrymal gland, which it supplies as well as the upper eyelid. Its branches within the orbit are : 1, a branch which passes down behind the lachrymal gland to communicate with the orbital branch of the maxillary nerve ; 2, filaments to the lachrymal gland. It then pierces the palpebral ligament to supply the skin of the upper eyelid.

Fourth Cranial Nerve. — This nerve enters the orbit through the sphenoidal fissure above the other nerves. It runs along the inner side of the frontal nerve, and enters the upper or orbital surface of the superior oblique, to which it is solely distributed. This nerve is joined in the outer wall of the cavernous sinus by filaments from the sympathetic. It communicates occasionally with the lachrymal, and the ophthalmic division of the fifth. Here also it sends backwards two or more filaments to supply the tentorium cerebelli.

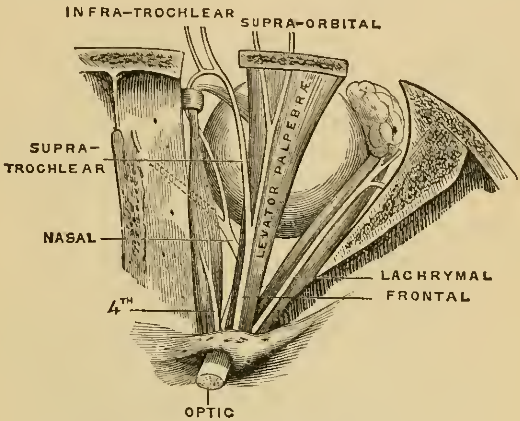


FIG. 26. — VIEW OF ORBIT FROM ABOVE.

Lachrymal Gland. — This gland is situated below the external angular process of the frontal bone. It consists of an orbital and palpebral portion — the former placed beneath the external angular process of the frontal bone in a depression for its reception, the latter extending to the margin of the upper lid. The orbital portion is oval, flattened, and curved, is held in place by a suspensory ligament attached to the bone, and extends one-fifth of the distance into the orbital cavity from this base. It is ¾ of an inch (19 mm.) from before backwards, ½ inch (13 mm.) wide, $\frac{1}{6}$ of an inch (3 mm.) thick, and weighs .8 of a gm., and has a volume of about 0.66 cm. It is limited externally by the external palpebral ligament, internally by the edge of the superior rectus. The palpebral portion is quadrilateral, smaller, thinner, and is in contact with the palpebral conjunctiva. It is ⅓ of an inch (9 mm.) long, nearly as wide, and $\frac{1}{12}$ of an inch (2 mm.) thick. The lachrymal gland empties

by ten to fifteen excretory ducts which run parallel and perforate the conjunctiva in a row on the upper lid ¼ of an inch (6.5 mm.) above the tarsal cartilage near the external canthus. They are not easily discovered in the human eye; in that of the horse or bullock they are large enough to admit a small probe. The secretion of the gland keeps the surface of the cornea constantly moist and polished; but if dust, or any foreign substance, irritate the eye, the tears flow in abundance and wash it off.

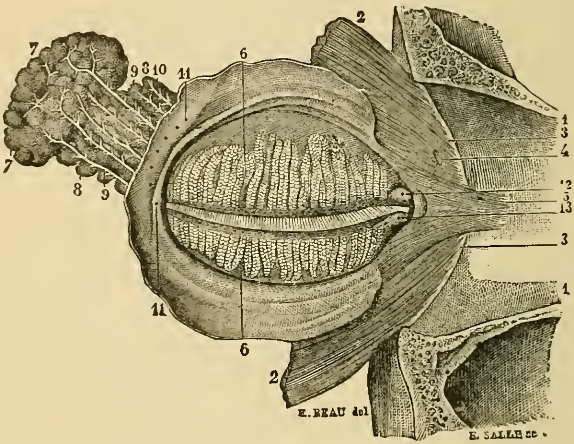


FIG. 27. — LACHRYMAL GLAND.

7, 7. Orbital portion of the lachrymal gland. 8, 9, 10. Palpebral portion of this gland. 11, 11. Mouths of its excretory ducts.

All the muscles of the orbit, with the exception of the inferior oblique, arise from the margin of the foramen opticum, and pass forwards, like ribbons, to their insertions.

Levator Palpebrae. — This muscle *arises* from the roof of the orbit, above and in front of the optic foramen, and above the origin of the superior rectus. It gradually increases in breadth, and terminates in a broad, thin aponeurosis, which is *inserted* into the upper surface of the tarsal cartilage by a broad aponeurosis. It is constantly in action when the eyes are open, in order to counteract the tendency of the lids to fall. It is, from its position and origin, closely associated with the superior rectus; its action involves that of the rectus superior as well. "Hansell & Reber" (Muscular Anomalies of the Eye). As sleep approaches, the muscle relaxes, the eyes feel heavy, and the lids

close. Its nerve comes from the superior division of the third nerve, and enters it on its under or ocular aspect.

Obliquus Superior. — This muscle *arises* from the inner side of the optic foramen. It runs forwards along the inner and upper side of the orbit, and terminates in a round tendon, which passes through a fibro-cartilaginous loop — *trochlea* — attached to the trochlear fossa in the frontal bone. From the loop the tendon is reflected backwards, downwards, and outwards at an angle of 53° with the first portion of the muscle, beneath the superior rectus, and is *inserted* by an expanded tendon into the outer part of the sclerotic coat, midway between the cornea and the entrance of the optic nerve, 16 mm. from the limbus. The loop is lined by a synovial membrane, which is continued

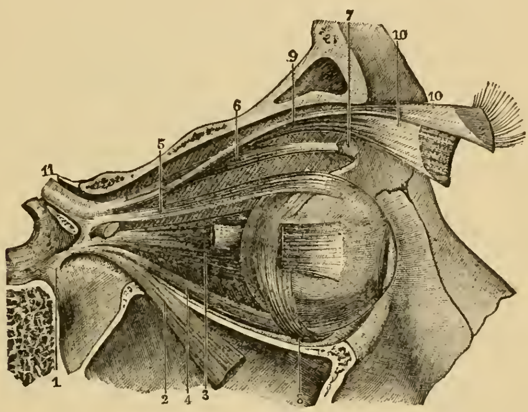


Fig. 28. — Muscles of the Eye. Ligament of Zinn.

1. Attachment of the ligament of Zinn — showing the three tongue-like projections, from its annular parts surrounding the optic nerve, to the internal, external, and inferior recti muscles. 2. External rectus, incised and deflected downwards to show the internal rectus. 3. Internal rectus. 4. Inferior rectus. 5. Superior rectus. 6. Superior oblique. 7. Pulley for the superior oblique muscle. 8. Inferior oblique. 9. Levator palpebræ. 10. Portion of the orbicularis palpebrarum. 11. Optic nerve.

over the tendon. The *action* of this muscle will be considered with that of the inferior oblique. It is supplied by the fourth nerve, which enters the back part of its upper surface.

The frontal nerve and levator palpebræ are now to be cut through the middle and reflected, the front part forwards and the hind part backwards. On its under aspect is seen the twig from the upper division of the third nerve entering it. On reflecting this muscle the superior rectus is exposed.

The *superior rectus arises* by a tendinous origin from the upper

margin of the optic foramen and from the sheath of the optic nerve, and is *inserted* by a broad, thin tendon (which invaginates Tennon's capsule) into the sclerotic coat. This tendon is inserted anterior to the equator of the globe, and 8 mm. posterior to the corneo-scleral border; is 5.8 mm. long. The largest area of the muscle on cross section is 11.⅓ mm., and its length is 41.8 mm. (Hansell & Reber.)

Action. — "It controls the upper half of the field of fixation, turns the eye vertically up, this vertical movement increasing as the eye is abducted, and diminished as the eye is adducted; it also rotates the cornea horizontally nasalwards, and tilts the upper end of the cornea in, more in adduction, less in abduction." Hansell & Reber.

Dissection. — Reflect this muscle by cutting through the middle, and, in doing so, observe a filament from the third nerve entering its under aspect. After the removal of a quantity of granular fat, the following objects are exposed: beneath the muscle are the optic nerve, the ophthalmic artery and vein, the nasal nerve and its ciliary branches crossing over the optic nerve, and further forwards is the reflected tendon of the superior oblique; on the outer side of the optic nerve, and close to the ophthalmic artery, is the lenticular ganglion, with numerous ciliary filaments passing forwards from it to enter the sclerotic. The student should now trace backwards the two roots which enter the upper and lower angle respectively of the ganglion, the upper being its sensory branch from the nasal, the lower its motor root from the lower division of the third nerve. Further back should be traced the third, the nasal branch of the ophthalmic, and the sixth nerves passing between the two heads of the external rectus to their respective destinations. The ophthalmic artery and its branches may also at this stage be exposed and cleaned.

Nasal Nerve. — This is one of the three divisions of the ophthalmic branch of the fifth, and is usually the first branch given off (Fig. 25, p. 65). It enters the orbit through the sphenoidal fissure between the two origins of the external rectus, and between the two divisions of the third n. It then crosses obliquely over the optic nerve, beneath the levator palpebræ and the superior rectus, towards the inner wall of the orbit. After giving off the *infra-trochlear* branch, the nerve passes out of the orbit between the superior oblique and the internal rectus, through the anterior ethmoidal foramen, into the

cranium, where it lies beneath the dura, upon the cribriform plate of the ethmoid bone. It soon leaves the cranium through the nasal slit near the crista galli, and enters the nose. Here it divides into two branches — an *inner* or *septal*, which supplies the mucous membrane of the front of the septum ; and an *outer*, the main continuation of the nerve — which runs in a groove on the under surface of the nasal bone, and distributes branches to the pituitary membrane of the outer part of the nose and the two lower turbinated bones ; it also gives off a superficial branch, which emerges between the nasal bone and the cartilage, under the name of the *naso-lobular*, and is distributed to the skin of the tip and ala of the nose (Fig. 24, p. 63).

The nasal nerve gives off the following branches in the orbit :

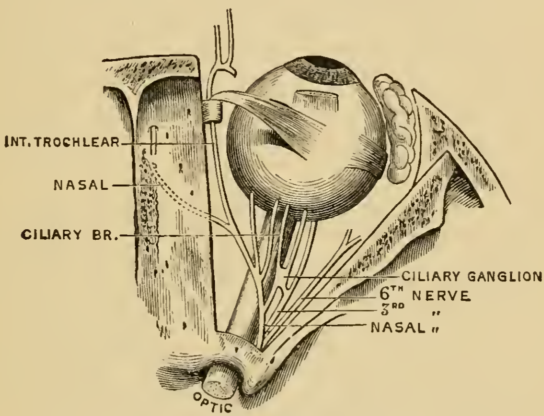


Fig. 29. — View of Optic and Lower Nerves of Orbit.

a. One slender filament to the *lenticular ganglion* (forming its upper or long root) is given off from the nasal nerve as it passes between the heads of the external rectus close to the optic nerve. It is about half an inch long, and enters the posterior-superior angle of the ganglion.

b. Two or three *long ciliary nerves.* They run along the inner side of the optic nerve to the back of the globe of the eye. They are joined by filaments from the lenticular ganglion, and pass through the sclerotic coat to supply the iris (Fig. 29).

c. Infra-trochlear nerve. — This runs forwards along the inner side of the orbit, below the loop of the superior oblique, where it communicates with the supratrochlear branch of the frontal nerve. It passes to the inner angle of the orbit, and divides into filaments, which supply the skin of the eyelids, the caruncle, the lachrymal sac, and the sides of the nose.

Optic Nerve. — This nerve, having passed through the optic foramen, proceeds forwards and a little outwards for about an inch to the globe of the eye, which it enters on the

nasal side of its axis. It pierces the sclerotic and choroid coats, and then expands to form the retina. The nerve is invested by a dense fibrous coat derived from the dura, and by a thin one from the arachnoid, both of which pass forward as far as the sclerotic. At the optic foramen it is surrounded by the tendinous origins of the recti; in the rest of its course, by loose fat and by the ciliary nerves and arteries. It is pierced in its course through the orbit by the arteria centralis retinæ, which runs along with its vein in the middle of the nerve to the eyeball.*

Ophthalmic Artery. — This artery arises from the internal carotid, close by the anterior clinoid process. It enters the orbit through the optic foramen, outside and below the optic nerve; occasionally through the sphenoidal fissure. Its course in the orbit is remarkably tortuous. Situated at first on the outer side of the optic nerve, it soon crosses over it, and runs along the inner side of the orbit between the superior and internal recti, to inosculate with the internal angular artery (the terminal branch of the facial). Its branches arise in the following order: —

a. Lachrymal Artery. — This branch proceeds along the outer wall of the orbit above the external rectus, in company with the nerve of the same name, to the lachrymal gland. After supplying the gland, it terminates in the conjunctiva and eyelids. In the orbit it gives off some *malar* branches which pierce the malar bone to get to the temporal fossa, and anastomose with the deep temporal arteries. It also sends a branch backwards through the sphenoidal fissure to anastomose with the arteria meningea media or *midi duralis.*

b. Supra-orbital Artery. — This branch runs forwards with the frontal nerve under the roof of the orbit and upon the levator palpebræ. It emerges on the forehead through the supra-orbital foramen, where it communicates with the superficial temporal, frontal, and angular arteries.

c. Arteria Centralis Retinæ. — This small branch enters the optic nerve obliquely on the outer aspect close to the optic foramen. It runs in the centre of this nerve to the interior of the eye.

d. Ciliary Arteries. — These branches may be arranged in three groups. The *short ciliary*, twelve to fifteen in number, proceed tortuously forward with the optic nerve, and pierce the sclerotic coat at the back of the eye to supply the choroid coat and the iris. The *long ciliary*, two in number, run on each side of the optic nerve, enter the sclerotic, and pass horizontally forward, one on each side of the globe, between the sclerotic and the choroid, nearly as far as the iris, where each divides into an upper and a lower branch. These branches of the two long ciliary arteries anastomose with the anterior ciliary and form two vascular circles, an outer at the circumference of the iris, the *circulus major*, and an inner at the free margin of the iris, the *circulus minor*. The *anterior ciliary* are branches of the muscular and lachrymal arteries and proceed with the tendons of the recti, and enter the front part of the sclerotic coat. In inflammation of the iris the vascular zone round the cornea arises from enlargement and congestion of the anterior ciliary arteries.

* A small branch from Meckel's ganglion, ascending through the spheno-maxillary fissure, is described by Arnold as joining the optic nerve.

e. Ethmoidal Arteries. — Of these arteries, two in number, the *anterior* and larger passes through the anterior ethmoidal foramen with the nasal nerve; the *posterior* enters the posterior ethmoidal foramen with the spheno-ethmoidal nerve. The anterior gives off branches to the frontal and anterior ethmoidal cells, and a nasal branch to the nose; it likewise gives off an anterior meningeal branch to the dura in the anterior fossa. The posterior is distributed to the posterior ethmoidal cells and upper part of the nose.

f. Muscular Branches. — There is an upper and a lower branch supplying respectively the upper and lower muscles: besides these, there are irregular branches from the lachrymal and supra-orbital arteries.

g. Palpebral Arteries. — These branches, a *superior* and an *inferior*, proceed from the ophthalmic artery near the front of the orbit. They are distributed to their respective eyelids, forming arches near the margins of the lids between the tarsal cartilages and the orbicularis palpebrarum, with branches from the lachrymal and the infra orbital arteries.

h. Nasal Artery. — This branch may be considered one of the terminal divisions of the ophthalmic. It leaves the orbit on the nasal side of the eye above the tendon of the orbicularis, and inosculates with the angular and nasal arteries of the facial. It supplies the side of the nose and the lachrymal sac.

i. Frontal Artery. — This is the other terminal branch of the ophthalmic. It emerges at the inner angle of the eye, ascends, and inosculates with the supra-orbital artery. [The arteries of the orbit are noted for their twisted and contorted appearance; this taken together with the mass of fat in which they are lodged allows mobility of the eyeball and prevents injury to these vessels. A. H.]

Ophthalmic Veins. — There are two ophthalmic veins. The *superior* commences at the inner angle of the eye by a communication with the frontal and angular veins. It runs backwards above the optic nerve in a straighter course than the artery, receives the veins corresponding to the arteries of the upper and inner part of the orbit, and finally passes between the two heads of the external rectus, through the inner part of the sphenoidal fissure, to terminate in the cavernous sinus. The *inferior ophthalmic* vein is formed by the union of branches from the lower and outer part of the orbit, and proceeding backwards along the floor of the orbit, opens into the superior vein, or directly into the cavernous sinus. In front it sends a communicating vein through the spheno-maxillary fissure to join the pterygoid plexus.

Ophthalmic or Lenticular Ganglion. — This small ganglion,* of reddish color and about the size of a pin's head, is situated at the back of the orbit, between the optic nerve and the external rectus, on the outer side of, and usually closely adherent to, the ophthalmic artery. It is somewhat quadrilateral in shape, and receives its *sensory* or *long root* from the nasal nerve, which joins its posterior superior angle; its *motor* or *short root*, from the branch of the third nerve, going to the inferior oblique, which enters its posterior inferior angle; and its *sympathetic root* from the cavernous plexus which joins it at its posterior border, or in

* W. Marshall regards this ganglion, from its mode of development and from its relations in some of the lower vertebrates, to be connected more with the third nerve than the ophthalmic.

conjunction with its sensory root. The ganglion, thus furnished with motor, sensory, and sympathetic roots, gives off the *short ciliary nerves*. These, from eight to twelve in number, issue from the anterior upper and lower angles of the ganglion, usually four or five from the upper, the remainder from the lower. They run very tortuously with the optic nerve, pass through the back of the sclerotic coat, where they are joined by the long ciliary (from the nasal), and are distributed to the iris and the ciliary muscle. Since the ciliary nerves derive their motor influence from the third nerve, the iris must lose its power of contraction when this nerve is paralyzed.

Third Nerve, Motor Oculi. — The third nerve passes forwards in the outer wall of the cavernous sinus, and here receives one or two filaments from the cavernous plexus of the sympathetic. Just before it enters the inner end of the sphenoidal fissure it divides into two branches, both of which pass between the two heads of origin of the external rectus, separated from

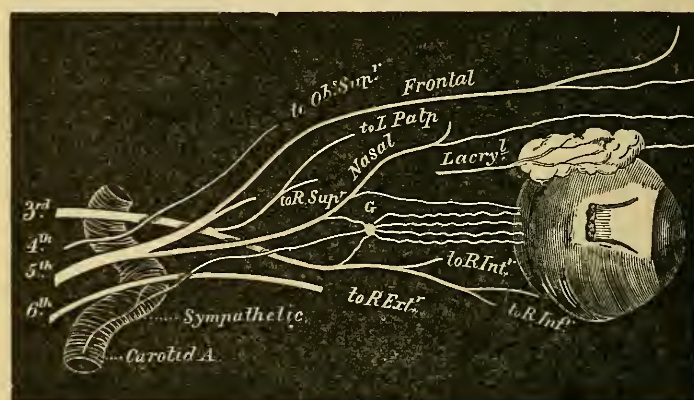


FIG. 30.—DIAGRAM OF THE NERVES OF THE ORBIT.

each other by the nasal nerve. The *upper* and smaller division has been already traced into the superior rectus and levator palpebræ. The *lower* division after a short course divides into three branches, one passing inwards under the optic nerve to supply the internal rectus, another passes to the inferior rectus, and a third runs along the floor of the orbit to the inferior oblique. This last-named branch sends a small twig upwards to the lenticular ganglion, mentioned in the description of this ganglion, and another to the inferior rectus.

What is the result of paralysis of the third nerve? Falling of the uppér eyelid (ptosis), external squint, dilatation and immobility of the pupil.

Sixth Nerve, Abducens. — This nerve lies in the inner wall of the cavernous sinus external to the internal carotid artery, passes through the sphenoidal fissure, and enters the orbit between the two heads of the external rectus. Here it lies below the lower division of the third and above the ophthalmic vein. The nerve terminates in fine filaments, which are distributed to the ocular surface of the external rectus. In the cavernus sinus it is joined by filaments from the carotid plexus, and in the orbit by a branch from Meckel's ganglion and from the ophthalmic nerve.

Respecting the motor nerves in the orbit, observe that they all enter the ocular surface of the muscles, with the exception of the fourth, which enters the orbital surface of the superior oblique. (Fig. 31.)

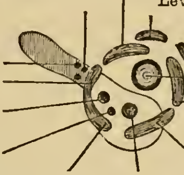


FIG. 31. — DIAGRAMMATIC REPRESENTATION OF ORIGINS OF OCULAR MUSCLES AT THE APEX OF THE RIGHT ORBIT. (After Schwalbe slightly altered.)

Recti Muscles. — The *internal* and *inferior recti* arise from a fibrous band — the *ligament of Zinn* — attached to the inner and lower borders of the optic foramen. The *external rectus* arises by two heads, the lower from the ligament of Zinn and the lower border of the sphenoidal fissure, the upper from the margin of the foramen opticum; between these heads pass in the following order, from above downward — the upper division of the third, the nasal, the lower division of the third, the sixth nerves, and the ophthalmic vein. Its tendon invaginates Tenon's capsule and is inserted by a tendon 3.7 mm. in length, in vertical line 7 mm. from the corneo-scleral junction, or *limbus*, into the sclera. The thickest area of the muscle is 16.73 mm. Its length 40.6 mm. (Hansell and Reber.)

Action. — It controls the outer half of the field of fixation and rotates the cornea horizontally temporal-wards. It has no action in tilting the upper end of the vertical meridian of the cornea either inwards or outwards. (Hansell and Reber.)

The four recti diverge from each other, one above, one below, and one on each side of the optic nerve.

Internal Rectus. — The internal rectus arises by a tendon common to it and the inferior rectus from the inner margin of the optic foramen, passes forward, lying close to the inner wall of the orbit, and is inserted into the sclera by a tendon (which invaginates Tenon's capsule), 8.8 mm. in length, in the vertical line 10.3 mm., and 6.5 mm. from the corneo-scleral junction, or *limbus*. *Action.*— It controls the inner half of the field of fixation, rotates the cornea horizontally nasal-wards, and has no torsional action. The thickest area of the muscle on horizontal section is 17.39 mm., and its length is 40.8 mm. (Hansell and Reber.)

Inferior Rectus. — The inferior rectus *arises* immediately below the optic foramen in the most internal part of the sphenoidal fissure by a tendon common to it and the internal rectus. It lies close to the floor of the orbit, and is inserted by a tendon which invaginates Tenon's capsule into the sclera 8 mm. from the corneo-scleral junction or *limbus*. This tendon is 5.8 mm. in length, in the horizontal line 10.6 mm. The largest area of the muscle on section is 11⅓ mm., and its length 41.8 mm. *Action.*—It controls the lower half of the field of fixation, turning the eye vertically down; the vertical movement increasing with adduction, diminishing with abduction; it also turns the eye laterally in, and rotates the upper end of the vertical meridian of the cornea out, these effects increasing as the eye is adducted, decreasing as it is abducted. (Hansell and Reber.)

The recti muscles enable us to direct the eye towards different points. It is obvious that by the single action of one, or the combined action of two, the eye can be turned towards any direction.

The rectus superior is supplied by the upper division of the third nerve; the rectus internus, the rectus inferior, and obliquus inferior, by the lower division. The rectus externus is supplied by the sixth.

Follow the recti to the eye, in order to see the tendons by which they are inserted. Notice also the anterior ciliary arteries, which run to the eye along the tendons. The congestion of these little vessels occasions the red zone round the cornea in iritis. It has been already mentioned that the tendons are invested by a fascia, which passes from one to the other, forming a loose tunic — *capsule of Tenon* — over the back of the

eye. This tunic consists of two layers with an intermediate space, lined with flat cells, thus allowing free mobility of the globe. It is this fascia which resists the passage of the hook in the operation for the cure of squinting. Even after the complete division of the tendon the eye may still be held in its faulty position if this tissue, instead of possessing its proper softness and pliancy, happen to have become contracted and unyielding. Under such circumstances it is necessary to divide it freely with the scissors.

By removing the conjunctival coat of the eye, the tendons of the recti are soon exposed. The breadth and the precise situation of their insertion deserve attention in reference to the operation for strabismus, and hence the precise measurements have been given with each muscle. It is, therefore, very possible that the lower part of a muscle may be left undivided in the operation, being more in the background than the rest. The tendon of the internal rectus is nearer to the cornea than either of the others.

Inferior Oblique. — This muscle *arises* by a flat tendon from the orbital plate of the maxilla on the outer side of the lachrymal groove. It runs outwards and backwards between the orbit and the inferior rectus, then curves upwards between the globe and the external rectus, and is *inserted* by a broad, thin tendon into the outer and back part of the eyeball 17.3 mm. from the corneo-scleral junction, or *limbus*.

Action. — It controls the upper half of the field of fixation, turns the eye laterally malarward, increasing in abduction, decreasing in adduction; turns the eye (vertically) upwards, increasing in adduction, diminishing in abduction. (Hansell and Reber.)

The tensor tarsi muscle has been described in the dissection of the face (p. 49).

Orbital Branch of the Maxillary Nerve. — This is always very small, and is sometimes absent. It comes from the trunk of the maxillary in the spheno-maxillary fossa, enters the orbit through the spheno-maxillary fissure, and divides into two branches. Of these, one, the *temporal*, lies in a groove in the outer wall of the orbit, and after sending a small branch to the lachrymal nerve in the orbit, passes through a foramen in the malar bone to the temporal fossa. It then pierces the temporal aponeurosis an inch (*2.5 c. m.*) above the zygoma, and supplies the skin of the temple communicating with the facial, and joining frequently with the auriculo-temporal branch of the mandibular n. The other branch, the *malar*, passes along the outer part of the floor of the orbit, imbedded in fat, and makes its exit through a foramen in the malar bone, to supply the skin of the cheek over the malar bone (p. 63).

DISSECTION OF THE NECK.

Surface Marking. — Before the student reflects the skin of the neck he should examine the skin surface, which in some places is raised, in others depressed, indicating thereby unevenness of the subjacent structures. The neck is bounded above by a well-marked transverse ridge, indicating the lower border of the mandible, and at its lower part the neck is bounded by another ridge which corresponds with the clavicle. Crossing obliquely from the centre of the neck below to the mastoid process above is the rounded prominence caused by the sterno-mastoid, and crossing this muscle diagonally from its anterior to its posterior border is the external jugular vein, which varies in size in different subjects. In front and behind the sterno-mastoid are two triangular depressions; the posterior one, it will be seen, has its base at the clavicle, the anterior one at the mandible. The posterior triangle has the trapezius as its outer boundary, but this border is only well defined inferiorly, where the hollow becomes most marked, and takes the name of the supra-clavicular or Mohrenheim's fossa. In this is placed deeply the subclavian artery, the posterior belly of the omo-hyoid, and the brachial plexus. In front of the sterno-mastoid is another triangular hollow space with its base upwards; this is called the carotid triangle, for in it lies the carotid artery immediately beneath the anterior border of the sterno-mastoid. The body of the hyoid bone can always be felt in the middle line below the symphysis of the mandible. About a finger's breadth below the hyoid is the prominent pomum Adami of the thyroid cartilage, and a short distance below this cartilage is the cricoid, separated from the cartilage above by the crico-thyroid membrane. The cricoid cartilage corresponds with the fifth cervical vertebra, and from it the trachea passes down, gradually receding from the surface, so that there is, especially in emaciated subjects, a deep hollow — fonticulus gutturis — immediately above the sternum. In front of the second, third, and fourth rings of the trachea is the isthmus of the thyroid gland, and there are usually another four rings below these above the sternum, covered more or less by the depressor muscles of the os hyoides.

Dissection. — The head must be slightly raised, and the face turned from the side on which the dissection is to be made.

Then make a vertical incision through the skin, down the middle of the neck from the symphysis of the mandible to the sternum; a second along the clavicle to the acromion; a third along the base of the mandible as far as the mastoid process. Reflect the skin and subcutaneous fat, and expose the cutaneous muscle, called the *platysma myoides.* Between the platysma and the skin is a layer of adipose tissue, called the *superficial fascia.* It varies in thickness in different subjects, but is generally more abundant at the upper part of the neck, especially in corpulent individuals, in whom it occasions a double chin.

Platysma Myoides. — The *platysma myoides* is the thin cutaneous muscle covering the front and side of the neck. It arises from the subcutaneous tissue over the pectoralis major, trapezius, and deltoid muscles; thence proceeding obliquely over the clavicle and the side of the neck, its fibres become more closely aggregated, and terminate thus: The anterior cross those of the opposite platysma, immediately below the symphysis of the mandible, and are lost in the skin of the chin; the middle are attached along the base of the mandible; the posterior cross the masseter muscle, and terminate, partly in the subcutaneous tissue of the cheek, partly in the muscles at the corner of the mouth blending with the depressor anguli oris and orbicularis.*

The platysma forms a strong muscular defence for the neck. It is also a muscle of expression.† It is supplied with nerves by the cervical plexus, and by the cervical branch of the facial nerve.

Dissection. — Cut through the platysma near the clavicle

* Some of the uppermost fibres of this part of the platysma take the name of *musculus risorius:* this has been described among the muscles of the face.

† If the entire muscle be permanently contracted it may occasion wry-neck, though distortion from such a cause is an exceedingly rare occurrence. A case in point is related by Mr. Gooch (*Chirurg. Works*), in which a complete cure was effected, after the failure of all ordinary means of relief, by the division of the platysma a little below the mandible.

The platysma myoides belongs to a class of muscles called *cutaneous;* from their office of moving the skin. There are not many in man, except upon the neck and face, and there is a little one (*palmaris brevis*) in the the palm of the hand. To understand their use thoroughly we must refer to the lower orders of animals, in whom they fulfil very important functions, by moving not only the skin, but also its appendages. For instance, by muscles of this kind the hedgehog, porcupine, and animals of that family can roll themselves up and erect their quills; we are all familiar with the broad "*panniculus carnosus*" on the sides of herbivorous quadrupeds, which enables them to twitch their skins, and thus rid themselves of insects. In birds, too, these cutaneous muscles are extremely numerous, each feather having appropriate muscles to move it.

and turn it upwards. Beneath it lies the general investment of the neck, called the *deep cervical fascia.* Upon this fascia we trace the superficial branches of the cervical plexus of nerves, the external jugular vein, and a smaller vein in front, called the anterior jugular. These superficial veins are so variable in size and course that a general description only is applicable.

External Jugular Vein. — The *external jugular vein* is formed within the substance of the parotid gland by the junction of the temporal and internal maxillary veins. After receiving the transverse facial and posterior auricular veins, it appears at the lower border of the gland, crosses obliquely over the sterno-

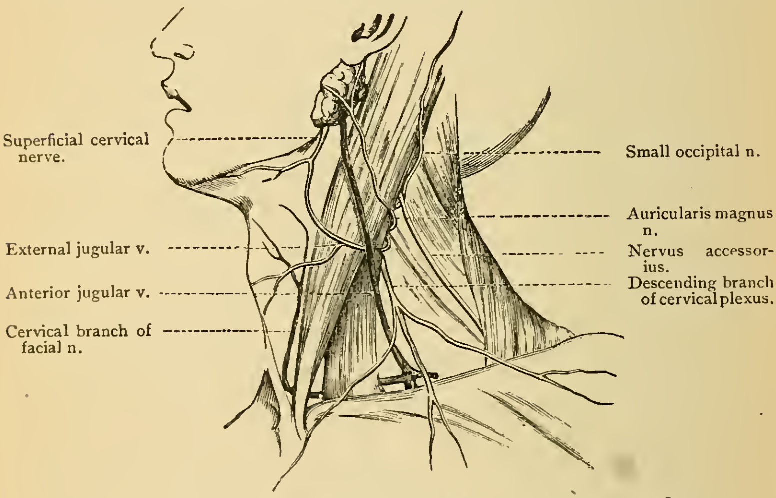


Fig. 32. — Diagram of the Superficial Nerves and Veins of the Neck.

mastoid muscle (Fig. 32), running along its posterior border, nearly as low down as the clavicle, where it pierces the deep cervical fascia and terminates in the subclavian vein. Accompanying the vein in its upper part is the auricularis magnus nerve, and crossing it, about the middle, is the superficial cervical nerve, both being branches of the superficial cervical plexus. It is usually provided with two pairs of valves — the lower, imperfect, close to its termination in the subclavian vein ; the upper, placed about an inch and a half (3.8 cm.) above the clavicle. A line drawn from the angle of the mandible to the middle of the clavicle would indicate its course. To trace the vein, during life, press upon it just above the clavicle ; but do not be

surprised if you fail to find it ; it is sometimes wanting, and frequently very small.

Near the angle of the mandible the external jugular vein communicates by a large branch with the internal jugular, and about its middle it is joined by a large vein — *posterior external jugular* — from the occipital region.

Before its termination the external jugular vein generally receives the supra-scapular, posterior scapular, and other unnamed veins : a disposition very embarrassing to the surgeon, because there is a *confluence of veins immediately over the subclavian artery* in the place where it is usually tied.

Anterior Jugular Vein. — The *anterior jugular vein* is situated more in the middle of the neck, and is much smaller than the external jugular. It commences by small branches below the chin, and runs down the front of the neck, nearly to the sternum ; it then curves outwards, beneath the sterno-mastoid muscle, and opens either into the external jugular or the subclavian vein. We commonly meet with two anterior jugular veins, one on either side ; immediately above the sternum they communicate by a transverse branch.

The size of the anterior jugular vein is inversely proportionate to that of the external jugular. When the external jugular is small, or terminates in the internal jugular, then the anterior jugular becomes an important supplemental vein, and attains considerable size. It is not uncommon to find it a quarter of an inch (6 mm.) in diameter, and we have seen it nearly half an inch (12.5 mm.). These varieties should be remembered in tracheotomy.

Superficial lymphatic glands are sometimes found near the cutaneous veins of the neck. From four to six in number, they are small and escape observation unless enlarged by disease. One or two are situated over the sterno-mastoid muscle ; others, near the mesial line.

Cutaneous Nerves of the Neck. — The cutaneous nerves of the neck are the superficial branches of the cervical plexus ; the plexus itself cannot at present be seen. It is formed by the communications of the anterior divisions of the four upper cervical nerves, and lies under the sterno-mastoid muscle, close to the transverse processes of the four upper cervical vertebræ, resting on the levator anguli scapulæ and the scalenus medius. The superficial branches of the plexus emerge from beneath the posterior border of the sterno-mastoid, and take different directions. They are named thus (Fig. 32) : —

Superficial branches of the cervical plexus.	Ascending branches	Great auricular. Small occipital.
	Transverse branch	Superficial cervical.
	Descending branches	Sternal. Clavicular. Acromial.

The *great auricular n.* comes from the second and third cervical nerves, winds round the posterior border of the sterno-mastoid, and ascends obliquely over that muscle, near the external jugular vein, towards the parotid gland. Near the gland it divides into two principal branches, of which the *anterior* or *facial* branches are distributed to the skin over the parotid gland, where they join branches from the facial nerve, and to the side of the cheek; the *posterior* or *auricular*, after ascending a short distance, give off a branch, which ramifies mainly upon the cranial aspect of the cartilage of the ear; and a smaller branch, the *mastoid*, which supplies the skin over the mastoid process. Other filaments of this nerve communicate in the substance of the parotid gland with branches of the facial nerve.

The *small occipital n.* comes from the second cervical nerve, and is occasionally double. It ascends along the posterior border of the sterno-mastoid muscle to the occiput, where it supplies the back of the scalp, and communicates with the great occipital, the great auricular, and the posterior auricular nerves. It also sends off one branch, which is distributed to the skin of the temporal region, and another *auricular* to the pinna of the ear. Beneath the sterno-mastoid this nerve commonly forms a loop, which embraces the nervus accessorius, and sends a branch to it.

The *superficial cervical n.* comes from the second and third cervical nerves. It passes transversely forwards over the sterno-mastoid muscle, and supplies the front of the neck. Some of its filaments ascend towards the mandible, and join the cervical branch of the facial nerve; other filaments descend and supply the skin in front of the neck as low as the sternum.

The *descending* or *supra-clavicular* branches are derived from the third and fourth cervical nerves, and divide into three branches, which cross over the clavicle, and supply the skin of the front of the chest and shoulder. Of these, one, called the *internal* or *sternal*, supplies the skin over the sternal end of the clavicle and the upper part of the sternum; another, the *middle* or *clavicular*, passes over the middle of the clavicle, and is distributed to the skin over the pectoral muscle, the mammary gland, and the nipple; the third, named *external* or *acromial*, crosses over the trapezius and acromion to supply the skin of the shoulder.

Reviewing these cutaneous branches of the cervical plexus, we find that they have a very wide distribution, for they supply the skin covering the following parts — viz., the ear, the back of the scalp, the side of the cheek, the parotid gland, the front and side of the neck, the upper and front part of the chest and shoulder.

Cervical Branch of the Facial Nerve. — Look for this branch beneath the fascia near the angle of the mandible (p. 80). It leaves the parotid gland, and, piercing the deep cervical fascia, divides into filaments which curve forwards below the mandible; some of these, forming arches, join the superficial cervical branch of the cervical plexus; others supply the platysma and skin.

Deep Cervical Fascia. — Now turn your attention to the membranous investment called the *deep cervical fascia,* which encloses the several structures of the neck. In some subjects

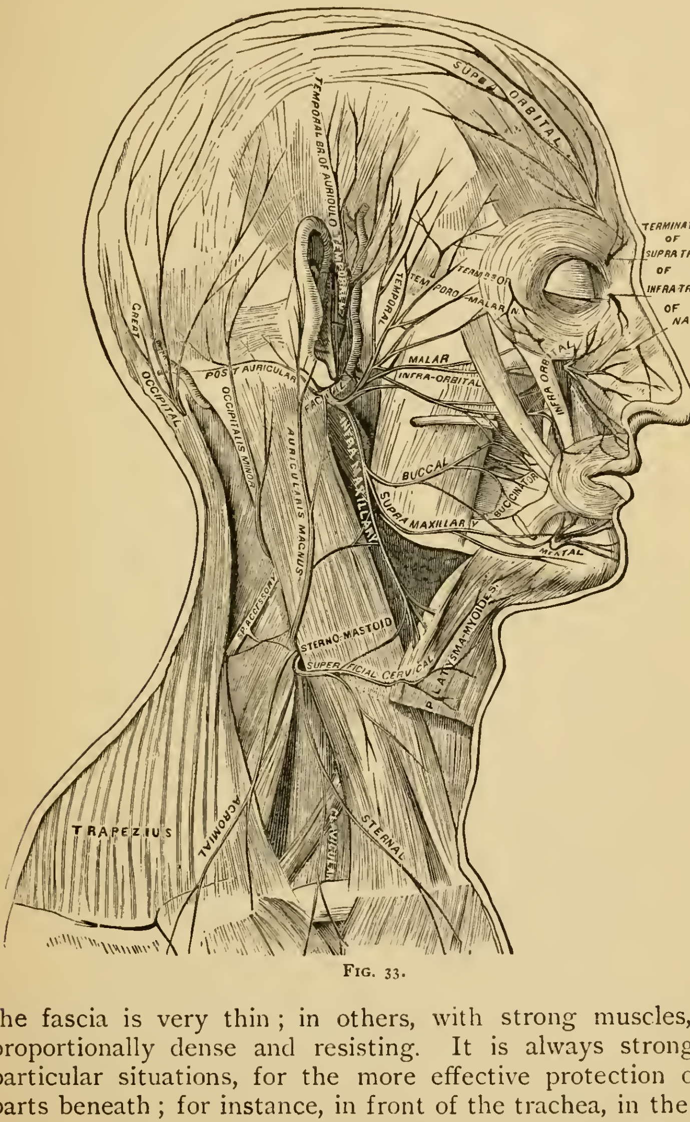


FIG. 33.

the fascia is very thin; in others, with strong muscles, it is proportionally dense and resisting. It is always stronger in particular situations, for the more effective protection of the parts beneath; for instance, in front of the trachea, in the fossa

above the clavicle, and below the angle of the mandible. It not only covers the soft parts of the neck collectively, but, by its inflections, forms separate sheaths for the muscles, vessels, and glands. It isolates them, and keeps them in their proper relative position. A lengthened description of its numerous layers would be not only extremely tedious, but unintelligible, without considerable knowledge of the anatomy of the neck. We propose, therefore, to give only a general outline of the fascia, and of its principal layers, commencing from behind.

Tracing it from behind, we find that the cervical fascia (sometimes called *deep cervical* or *muscular fascia* of the neck) is attached to the ligamentum nuchæ and to the spinous and transverse processes of the cervical vertebræ. From these attachments it passes forwards over the posterior triangle of the neck to the posterior border of the sterno-mastoid, where it splits into two layers, superficial and deep, which invest that muscle and reunite at its anterior border. The superficial layer passes towards the mesial line, where it becomes continuous with the corresponding fascia of the opposite side. The layer which lies in front of the sterno-mastoid is attached above to the base of the mandible, and passes over the parotid gland to the zygoma, to the mastoid process, and the superior curved line of the occipital bone. Traced downwards, we find it attached to the clavicle and to the upper border of the sternum. In the middle line it is closely connected to the hyoid bone, and below the thyroid body divides into two layers, one being attached to the front of the upper border of the sternum, the other to the back of the upper border of the same bone. Between these layers there is a well-marked interval, containing more or less fat, and one or two small lymphatic glands. This layer forms investing sheaths for the depressor muscles of the os hyoides and larynx.

The deep layer — viz., that which passes beneath the sterno-mastoid — forms the common sheath for the carotid artery, internal jugular vein, and the pneumogastric nerve, which lie behind this muscle; the structures contained in the carotid sheath are separated from each other by delicate septa. The fascia is continued behind the pharynx (constituting the *prævertebral fascia*) to join the fascia of the opposite side, while another prolongation passes in front of the trachea beneath the sterno-thyroid muscle. Below, it is attached to the first rib, to which it binds down the intermediate tendon of the omo-hyoid;

and still further down it is continuous in the chest with the pericardium. It may also be traced under the clavicle along the axillary vessels and nerves into the axilla. Above, it is attached to the angle of the mandible, from which it extends backwards to the styloid process, and forms the *stylo-mandibular* ligament. Thence it is attached to the base of the skull, the petrous portion of the temporal bone, and the basilar process of the occipital bone.

A correct knowledge of the attachments of the principal layers of the cervical fascia is essential to a right understanding of the course which pus takes when it forms in the neck. For instance, suppose the pus to be formed at the lower part of the neck. If it be seated under the superficial layer (which is attached to the clavicle), it may burrow beneath the clavicle into the axilla. But if it be seated beneath the deep layer (which is attached to the first rib), then it becomes more serious, since the pus may travel through the loose tissue by the side of the pharynx, and make its way into the chest, where it may burrow down the anterior or the posterior mediastinum, and burst into the trachea or the œsophagus.

Besides forming sheaths for the several structures of the neck, there are other purposes to which the cervical fascia is subservient. The firm attachment of its layers to the sternum, the first rib, and the clavicle, forms a fibrous barrier at the upper opening of the chest, which supports the soft parts, and prevents their yielding to the pressure of the atmosphere during inspiration. Dr. Allan Burns * first pointed out this important function of the cervical fascia, and has recorded a case exemplifying the results of its destruction by disease.

Moreover, the great veins at the root of the neck, namely, the internal jugular, subclavian, and innominate, are so closely united by the cervical fascia to the adjacent bones and muscles, that when divided they gape. They are, as the French express it, "*canalisées*," and are therefore better able to resist the pressure of the atmosphere, which tends to render them flaccid and impervious during inspiration. But this anatomical disposition of the great veins makes them more liable to the entrance of air when wounded. Instances of death have been recorded, resulting from the sudden entrance of air into the veins during operations about the neck, or even the axilla.

* "Surgical Anatomy of the Head and Neck."

Sterno-cleido-mastoideus. — The sterno-cleido-mastoideus is the large muscle which passes obliquely across the neck. It *arises* by a rounded tendon from the upper part of the sternum, and by fleshy fibres from the sternal third of the clavicle. It is *inserted* by a thick tendon into the external surface of the mastoid process, and by a thin aponeurosis into about the outer half of the superior curved ridge of the occipital bone.

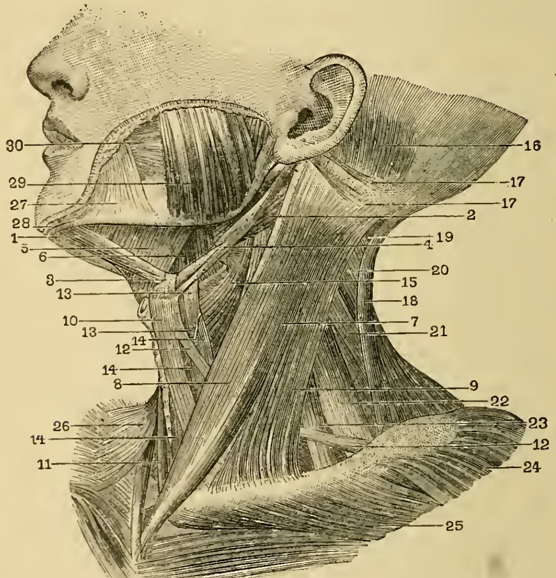


Fig. 34. — Sterno-cleido-mastoid M. and Muscles Above and Below the Hyoid Bone.

1. Anterior belly of the digastric on the left side. 2. Posterior belly of the digastric. 3. Tendon of the digastric and pulley through which it passes. 4. Stylo-hyoid pierced by the posterior belly of the digastric. 5. Mylo-hyoid m. 6. Hyo-glossus m., the anterior part being covered by the preceding muscle. 7. Sterno-cleido-mastoid m. 8. Sternal portion of the sterno-mastoid m. 9. Clavicular portion of the sterno-mastoid m. 10. Sterno-hyoid m. of the left side. 11. Sterno-hyoid m. of the right side. 12, 12. Anterior and posterior bellies of the omo-hyoid m. 13. Thyro-hyoid m. 14, 14 Sterno-thyroid m. 15. Anterior part of the inferior constrictor m. of the pharynx. 16. Occipito-frontalis m. 17, 17. The two fasciculi of the retrahens aurem. 18. Trapezius m. 19. Capitis portion of the splenius capitis et colli m. 20. Colli portion of the same m. 21. Levator anguli scapulæ. 22. Scalenus posticus m. 23. Scalenus anticus m. 24. Superior part of the deltoid m. 25. Clavicular portion of the pectoralis major m. 26. Anterior and inte ior part of the platysma-myoid m. 27. Depressor anguli oris m. 28. Transverse portion of the preceding m., blending with, although external to, the depressor labii inferioris m 29. Masseter m. 30. Buccinator m.

The sternal origin of the muscle is at first separated from the clavicular by a slight interval; subsequently the sternal fibres gradually overlap the clavicular. The muscle is confined by its strong sheath of fascia, in such a manner that it forms a slight

curve, with the convexity forwards. Observe especially that its front border overlaps the common carotid artery; along this border we make the incision in the operation of tying the vessel.

Action of Sterno-mastoid. — When both sterno-mastoids act simultaneously they draw the head and neck forwards and downwards (the occiput being slightly depressed), and are therefore especially concerned in raising the head from the recumbent position. When one sterno-mastoid acts singly, it turns the head obliquely towards the opposite shoulder (elevating the chin); in this action it co-operates with the splenius of the other side.* On emergency, the sterno-mastoid acts as a muscle of inspiration, by raising the sternum; its fixed point being, in this case, at the head.

The sterno-mastoid is supplied by three nutrient arteries — an upper, a middle, and a lower. The upper sterno-mastoid artery, a branch of the occipital, enters the muscle with the n. accesorius (*spinal accessory*) close to the mastoid process of the temporal bone; the middle mastoid is a branch of the superior thyroid, and enters the under surface of the muscle, crossing over the common carotid on a level with the thyroid cartilage; the lower mastoid is a branch of the supra-scapular, and supplies the clavicular portion of the muscle, close to its origin.

The sterno-mastoid is supplied with nerves by the n. accessorius (*spinal accessory*), and by branches from the deep cervical plexus; these branches come from the second and sometimes the third cervical nerves.

Triangles of the Neck. — Anatomists avail themselves of the oblique direction of the sterno-mastoid muscle to divide the neck on each side into two great triangles, an anterior and a posterior (Fig. 35). The base of the anterior triangle is formed by the mandible, its sides by the mesial line and the front border of the sterno-mastoid. The posterior has the clavicle for the base, while the sides are defined by the hind border of the sterno-mastoid and the front border of the trapezius.

The omo-hyoid muscle, which crosses the neck under the sterno-mastoid, subdivides these primary triangles into four smaller ones (Fig. 35) of unequal size: an anterior superior, an anterior inferior, a posterior superior, and a posterior inferior. The direction of the omo-hyoid muscle renders their boundaries at once obvious.

Contents of Posterior Triangle.—The fat and connective

* The single action of the muscle is well seen when it becomes rigid and causes a wry-neck. Other means of relief failing, the division of the muscle near its origin is sometimes beneficial in curing the distortion. In deciding as to the propriety of this operation, we should be careful to examine the condition of the other muscles, lest, after having divided the sterno-mastoid, we should be disappointed in removing the deformity.

tissue must now be carefully removed from the posterior triangle. The following muscles will be seen forming its floor: viz., beginning from above, the splenius capitis, the levator anguli scapulæ, the scalenus medius and posticus, and a small portion of the serratus magnus. The posterior belly of the omo-hyoid crosses this triangle about an inch (*2.5 c. m.*) above the clavicle, and subdivides it into two unequal parts — an upper or *occipital,* and a lower or *supra-clavicular.** In the occipital triangle, the larger of the two, besides the muscles just mentioned (with the exception of the serratus magnus), are found

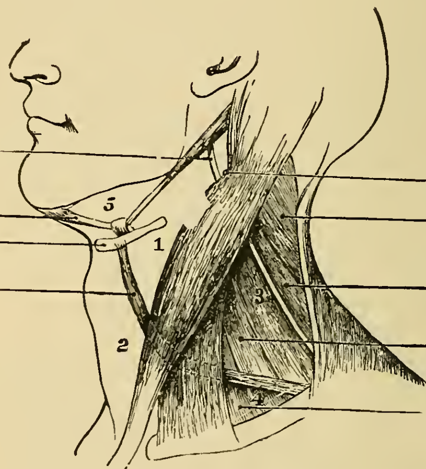


FIG. 35. — DIAGRAM OF TRIANGLES OF THE NECK.

1. Superior carotid triangle. 2. Inferior carotid triangle. 3. Occipital triangle. 4. Supra-clavicular triangle. 5. Submandibular triangle.

the descending branches of the cervical plexus, and passing obliquely downward from beneath the sterno-mastoid is the spinal accessory nerve, which enters the under part of the trapezius. Curving round the posterior border of the sterno-mastoid, and becoming superficial, are the ascending and transverse branches of the superficial cervical plexus. The transversalis colli (posterior scapular) artery and vein, and its branch, the superficialis colli (which chiefly supplies the trapezius), cross transversely outwards the lower part of the space. A chain of lymphatic glands is also found along the posterior border of the sterno-mastoid.

* Mohrenheim's fossa.

Nervus Accessorius.—The upper part of the sterno-mastoid is traversed obliquely by a large nerve called the spinal accessory or n. accessorius. This nerve—the eleventh cranial—consists of two parts; one, the *accessory*, arises from the side of the medulla below the pneumogastric nerve; the other, the *spinal* part, arises from the cervical portion of the spinal cord by a series of filaments from the lateral tract as low down as the sixth cervical vertebra. The spinal portion ascends between the ligamentum denticulatum and the posterior roots of the spinal nerves, through the foramen magnum into the skull. Within the cranium the two parts unite and form a single nerve, which leaves the skull through the foramen jugulare. Here the *accessory* portion is connected with the ganglion of the root of the pneumogastric by several filaments; and lower down it again joins the pneumogastric at the ganglion of the trunk, below which the two nerves become blended. The accessory and spinal portions communicate in the foramen jugulare. Below the foramen the *spinal* part runs behind the internal jugular vein, the digastric and stylo-hyoid muscles, and then pierces obliquely the upper third of the sterno-mastoid. Emerging beneath its outer border, it crosses the posterior triangle of the neck to the under surface of the trapezius, to which it is distributed. The nervus accessorius supplies also the sterno-mastoid in its passage through it, and here it joins some branches from the third cervical. After leaving the muscle it is joined by branches from the second and third cervical nerves. Beneath the trapezius it forms a plexus with the third and fourth cervical nerves. The upper mastoid artery, a branch of the occipital, enters the sterno-mastoid with the nerve.

Supra-Clavicular Triangle.*—The *supra-clavicular* or *subclavian triangle* is bounded below by the clavicle, in front by the outer border of the sterno-mastoid, and above by the posterior belly of the omo-hyoid muscle. The area of the triangle thus formed will vary in proportion to the obliquity of the omo-hyoid muscle, and the extent to which the sterno-mastoid and trapezius are attached to the clavicle. The depth of the vessels and nerves contained in this space depends not only upon the degree to which the clavicle arches forwards, but varies with the elevation and depression of the shoulder.

Dissection.—The descending branches of the cervical plexus, together with some fat, should now be cut through and turned aside, when a layer of a fascia which binds down the omo-hyoid muscle to the clavicle will be exposed. Beneath this is a deeper layer of fascia, which covers the subclavian vessels and brachial plexus of nerves, and descends with them under the clavicle into the axilla. Between these two layers we meet with more or less fat and connective tissue and lymphatic glands continuous with those in the axilla. It will be easily understood how a collection of pus in the axilla may ascend in front of the vessels and point above the clavicle, or, *vice versâ*, how pus formed in the neck may travel under the clavicle and point in the axilla.

Near the posterior border of the sterno-mastoid muscle the external iugular vein passes through both layers of the deep

* Mohrenheim's fossa.

fascia and terminates in the subclavian; but before its termination it is commonly joined by the supra-scapular, the posterior scapular, and other unnamed veins proceeding from the surrounding muscles ; so that there is in this situation a *confluence of veins*, which, when large or distended, is exceedingly embarrassing.

The fascia and the glands should be removed, and the following objects carefully dissected. Behind and nearly parallel with the clavicle is the supra-scapular (transversalis humeri) artery, a branch of the thyroid axis. A little higher is the transversalis colli, or posterior scapula (commonly a branch of the thyroid axis), which crosses the lower part of the neck towards the posterior superior angle of the scapula. Both these arteries are very irregular in respect to their origin, *the last particularly* being often given off from the subclavian in the third part of its course. Search for the outer border of the scalenus anticus, which descends from the transverse processes of the cervical vertebræ to the first rib; running down longitudinally upon it may be seen the phrenic nerve. The subclavian vein lies upon the first rib in front of the insertion of the anterior scalene muscle behind the clavicle, so that it is not usually seen in this triangle. The subclavian artery rises up into the neck as high as an inch (*2.5 c. m:*) above the clavicle, and sometimes on the right side as high as an inch and a half (*?.8 c. m.*). It appears higher than the vein, emerging beneath the outer border of the scalenus anticus, and care must be taken to preserve the small branch from the brachial plexus, which crosses the artery and proceeds to the subclavius muscle. The large nerves constituting the brachial plexus come out between the scalenus anticus and medius, higher than the subclavian artery, and on a plane posterior to that vessel. These different objects will be described in detail hereafter.

Dissection of the Anterior Triangle. — The *anterior triangle* must now be dissected. In doing so, notice, before the deep cervical fascia is removed, the arching forwards of the anterior border of the sterno-mastoid muscle, which is connected to the mandible by the fascia, so that the common carotid artery is concealed from view before the parts are disturbed. The anterior triangle is bounded behind by the anterior border of the sterno-mastoid, in front by the middle line of the neck, and above by the lower border of the mandible. Covering the triangle are the superficial and deep cervical fasciæ and the platys-

ma; passing across it are the superficial cervical n., the submandibular branch of the facial nerve; and descending in front is the anterior jugular vein. This space is subdivided by the anterior belly of the omo-hyoid into a *superior* and an *inferior carotid* triangle, and above them is a third triangle mapped out by the converging bellies of the digastric muscle and the mandible, and is called the submandibular or *digastric* trangle (Fig. 35, p. 88).

The *inferior carotid triangle* is bounded above and below by the omo-hyoid and sterno-mastoid muscles, and in front by the middle line. The muscles forming its floor are the sterno-hyoid and sterno-thyroid muscles, and lying on them is the anterior jugular vein; in the middle line is the thyroid body covering the trachea.*

The *superior carotid triangle* has for its boundaries the sterno-mastoid, the omo-hyoid, and the posterior belly of the digastricus. Its muscular floor is formed by the hyo-glossus, the middle and inferior pharyngeal constrictors, and the thyro-hyoid. In this space are found the bifurcation of the common carotid into its external and internal divisions, and the following branches of the external carotid — the superior thyroid, lingual, facial, the occipital, and the ascending pharyngeal arteries — their accompanying veins and the internal jugular vein. The nerves seen are the hypoglossal, crossing over the external carotid, the submandibular branch of the facial, the spinal accessory, the superior and external laryngeal nerves, and in front of the carotid sheath is the descendens hypoglossi n.

The *digastric* triangle will be described subsequently (p. 106).

Now examine the flat muscles in front of the neck, which pull down the larynx and os hyoides — namely, the sterno-hyoid, sterno-thyroid, omo-hyoid, and thryo-hyoid.† Remove the fascia which covers them, disturbing them as little as possible, and take care of the nerves (branches of the descendens hypoglossi), which enter their outer borders.

Sterno-hyoid. — The sterno-hyoid *arises* from the back part of the sternum and posterior sterno-clavicular ligament, from the clavicle and occasionally from the cartilage of the first rib, and

* The vessels and nerves lying within and upon the carotid sheath are not seen, as they are situated beneath the anterior border of the sterno-mastoid.

† The sterno-hyoid and sterno-thyroid muscles often present slight transverse tendinous lines. These tendinous intersections are quite rudimentary in man; but in some animals with long necks, *e. g.*, the giraffe, they are so developed that each depressor muscle is composed of alternations of muscle and tendon.

is *inserted* into the lower border of the body of the os hyoides. It is supplied by the first three cervical nerves through the descendens and communicans hypoglossi entering on the deep surface near the upper extremity. *Action:* It draws down the hyoid bone after it has been elevated in swallowing; it also fixes the hyoid to allow the sucking motion by the tongue. This is the most superficial of the muscles in front of the neck. We cut in the mesial line between these muscles in tracheotomy.

Sterno-thyroid.— The sterno-thyroid *arises* from the back part of the sternum, below and internal to the origin of the sterno-hyoid, and the cartilage of the first rib, and is *inserted* into the oblique ridge on the ala of the thyroid cartilage. Nerve supply is from the loop of the descendens and communicans hypoglossi. *Action* is similar to the preceding muscle. This muscle is situated immediately under, and is much broader than, the sterno-hyoid.

The two sterno-hyoid muscles converge as they ascend to their insertions, and opposite the cricoid cartilage and the two or three upper rings of the trachea they are in contact with one another. The sterno-thyroid, however, diverge to their insertions, but are in contact below, the result of which is that the trachea is completely covered in front by muscular fibres.

Omo-hyoid. — The omo-hyoid consists of two fleshy portions connected by a tendon. It *arises* from the upper border of the scapula, and sometimes from the ligament over the notch, and is *inserted* into the lower border of the body of the os hyoides just external to the sterno-hyoid. From the scapula it comes nearly horizontally forwards across the lower part of the neck, and passes beneath the sterno-mastoid, *over* the sheath of the great vessels of the neck on a level with the cricoid cartilage; then, changing its direction, it ascends nearly vertically close to the outer border of the sterno-hyoid. Thus the muscle does not proceed straight from origin to insertion, but forms an obtuse angle beneath the sterno-mastoid muscle. The intermediate tendon is situated at the angle and is bound down to the first rib and the sternum by a process of the deep cervical fascia. *Action.* The object of this peculiar direction of the omo-hyoid appears to be to keep tense that part of the cervical fascia which covers the apex of the pleura, and thus to resist atmospheric pressure. It depresses the hyoid bone and may slightly elevate the scapula. It is supplied by the *descendens* (from the

12th n.) and communicans hypoglossi (from the 2d and 3d cervical nn.). Fig. 36, p. 94.

Relations of the Omo-hyoid. — At its origin the omo-hyoid is covered by the trapezius, then by the clavicle and subclavius, and lastly, by the sterno-mastoid and platysma myoides. It lies on the scalenus medius and anticus, the brachial plexus, the phrenic nerve, then on the internal jugular vein, pneumogastric nerve and common carotid artery enclosed within their common sheath, on the descendens hypoglossi, the sterno-thyroid, and thyro-hyoid muscles.

The descendens hypoglossi sends a separate branch to each belly of the omo-hyoid. These depressors are supplied with blood by the superior and inferior thyroid arteries.

Thyro-hyoid. — The thyro-hyoid *arises* from the oblique line on the ala of the thyroid cartilage, and runs up to be *inserted* into the lower border of the body and the inner half of the great cornu of the hyoid bone. This muscle is a continuation of the sterno-thyroid. It is supplied by a special branch of the hypoglossal nerve which enters the muscle close by its posterior border, in company with the hyoid branch of the lingual artery.

Action. — It elevates the thyroid cartilage in swallowing; is associated with the sterno-thyroid in depressing the hyoid bone. In front of the muscle are the omo-hyoid and sterno-hyoid muscles, and it covers the thyro-hyoid membrane, the thyroid cartilage, and the superior laryngeal vessels and nerve as they enter the larynx.

Action of the Depressor Muscles. — These musles depress the larynx in the utterance of low notes. That the larynx is raised or depressed, according to the height of the note, may be ascertained by placing the finger on it while singing through an octave. The omo-hyoid, in addition, is a tensor of the cervical fascia, and draws down the hyoid bone to its own side. The thyro-hyoid depresses the hyoid bone, or elevates the thyroid cartilage, according as the one or the other is the fixed point.

Dissection. — The sterno-mastoid muscle must now be cut transversely through the middle, and the two ends turned upwards and downwards, so that they may be replaced if necessary. This done, notice the strong layer of fascia which lies under the muscle and forms part of its sheath. It is attached to the angle of the mandible, thence descends over the large vessels of the neck, and is firmly connected to the clavicle and

first rib. This fascia prevents pus coming to the surface, when suppuration takes place by the side of the pharynx.

Remove the fascia, and clean the various structures beneath the sterno-mastoid, taking care not to cut away the descendens

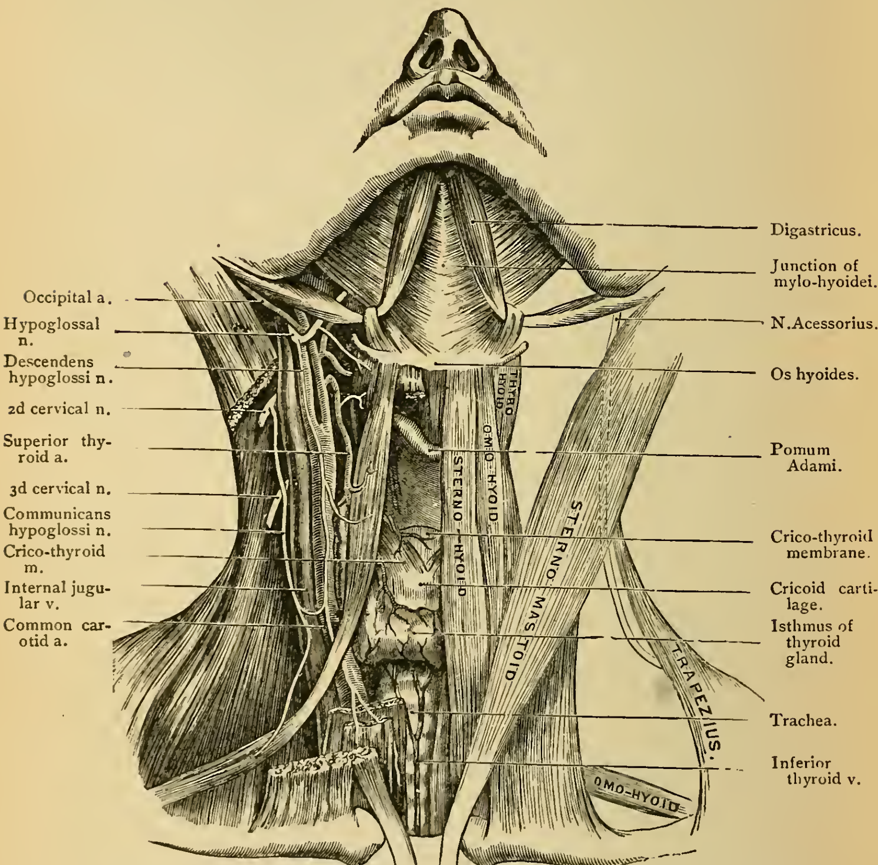


FIG. 36.—CENTRAL LINE OF NECK.—COURSE AND RELATIONS OF COMMON CAROTID ARTERY.

hypoglossi and communicantes hypoglossi nerves, which lie in front of the sheath of the common carotid. Dissect out the lymphatic glands which lie along the sheath of the large vessels.

Parts exposed beneath the Sterno-mastoid.—The objects exposed to view, when the muscle is reflected, are very

numerous. Among these the more important are: the sterno-clavicular articulation, the splenius capitis and colli, the posterior belly of the digastric, the levator anguli scapulæ, scalenus medius and anticus, omo-hyoid, sterno-hyoid, and sterno-thyroid muscles; the occipital artery, the common carotid artery and its division, the internal jugular vein, the subclavian artery and the branches of the first part of its course, the cervical plexus,

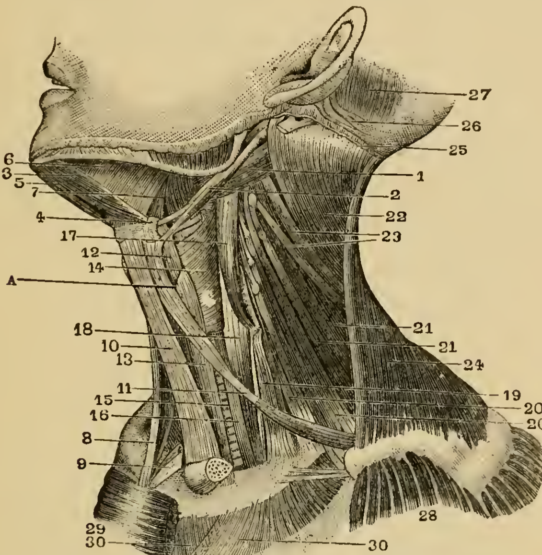


FIG. 37.—MUSCLES OF THE HYOID AND INFRA-HYOID REGIONS.

1. Posterior belly of the digastric m. 2. Stylo-hyoid m. 3. Anterior belly of the digastric m. 4. Tendon and pulley of this muscle. 5. Anterior belly of the right digastric m. 6. Mylo-hyoid m. 7. Hyo-glossus m. 8. Sternal portion of the right sterno-mastoid m. 9. Sternal portion of the left sterno-mastoid m. 10. Sterno-hyoid m. 11. Tendon of the omo-hyoid m. 12. Thyro-hyoid m. 13. Sterno-thyroid m. A. Oblique line of the thyroid cartilage to which the two preceding muscles are attached. 14. Inferior constrictor m. of the pharynx. 15. Trachea. 16. Œsophagus. 17. Rectus capitis anticus major m. 18. Longus colli m. 19. Scalenus anticus m. 20, 20. Scalenii medius and posticus mm. 21, 21. Fasciculi of the levator anguli scapulæ m. passing to be inserted to the transverse processes of the cervical vertebræ. 22. Splenius capitis m. 23. Splenius colli m. 24. Trapezius m. 25. Attachment of the sterno-mastoid m. 26. Attachment of the two fasciculi of the retrahends aurem m. 27. Occipito-frontalis m. 28. Deltoid m. 29. Attachment (sternal) of the right and left pectoralis major mm. 30. Intercostal muscles.

and the lower cervical nerves which form the brachial plexus; the phrenic, pneumogastric, hypoglossal, and spinal accessory nerves, the descendens and communicantes hypoglossi nerves; the subclavian vein and its tributaries; and lastly, a small part of the parotid gland, and the three sterno-mastoid arteries. On the left side, in addition, we find the thoraic duct; on the right side, the right lymphatic duct.

Course and Relations of the Common Carotid. — The *common carotid artery* is now exposed in the whole extent of its course in the neck. It arises, on the right side from the arteria innominata, behind the upper part of the right sterno-clavicular articulation; on the left, from the arch of the aorta. It ascends in front of the bodies of the cervical vertebræ, by the side of the trachea, thyroid gland, and larynx, as high as the upper border of the thyroid cartilage, and then divides into the external and internal carotids. *Surgical landmarks.* — Thus, a line drawn from the sternal end of the clavicle to a point midway between the mastoid process and the angle of the mandible will nearly indicate its course. It is contained in a sheath of the deep cervical fascia, together with the internal jugular vein and the pneumogastric nerve. The vein lies on the outer side of, and parallel with, the artery; the nerve lies behind and between the artery and the vein. The structures contained within this sheath are separated from each other by a thin septum of fascia, so that each has a separate investment. Owing to the increasing breadth of the larynx, the two common carotid arteries, which at their origin lie near together, are separated by a wide interval at their point of division.

At the lower part of the neck the carotid artery is deeply placed, but as it ascends it becomes more superficial, although it has the appearance of being deeply situated owing to the prominence of the thyroid cartilage. *In front* the artery is covered by the skin, superficial fascia, platysma myoides, deep fascia, the sternal portion of the sterno-mastoid, the sterno-hyoid, and thyroid muscles, and, on a level with the cricoid cartilage, it is crossed by the omo-hyoid. Above this point the artery becomes more superficial, and is covered by the integument, platysma, the cervical fasciæ, the middle sterno-mastoid artery, and only slightly overlapped by the sterno-mastoid. Lying upon the sheath of the artery, we find the descendens hypoglossi joined by the communicantes hypoglossi nerves. The sheath is crossed by the facial, the superior, and middle thyroid veins, and lower down by the anterior jugular vein, all of which empty themselves into the internal jugular. This is the general rule, and especial attention should be directed to it, because the veins are liable to be overlooked and injured in the operation of tying the carotid. To the *inner side* of the artery we find the trachea, the thyroid body, the recurrent laryngeal nerve, the inferior thyroid artery, the external laryngeal nerve,

the inferior constrictor of the pharynx, and the larynx. On the *outer side* are the pneumogastric nerve and the internal jugular vein. *Behind* the artery are the sympathetic nerve, the inferior thyroid artery, the recurrent laryngeal nerve; and lastly, the

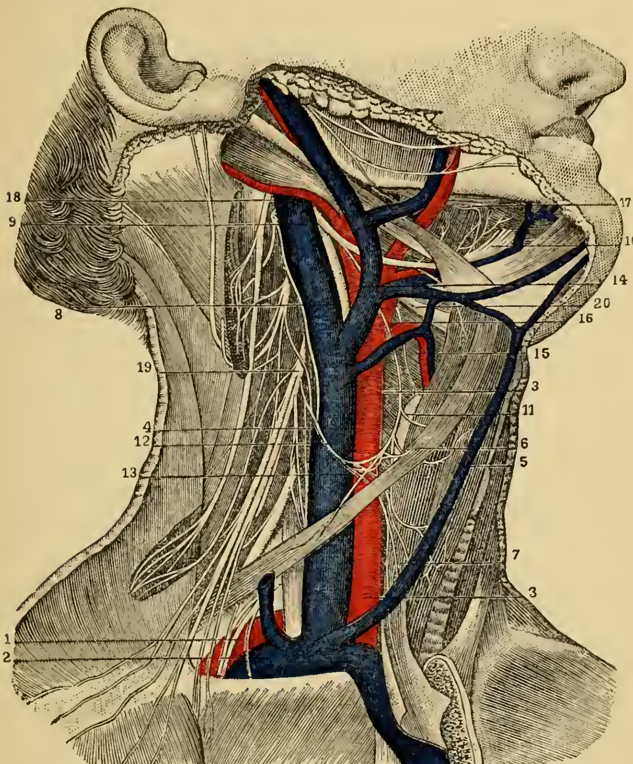


FIG. 38.—RELATIONS OF THE CARTOID ARTERIES.

1. Subclavian artery. 2. Subclavian vein. 3, 3. Common carotid artery. 4. Internal jugular vein. 5. Anterior jugular vein passing in front of the common carotid artery to empty into lower part of the jugular vein. 6. Omo-hyoid muscle. 7. Sterno-hyoid muscle. 8. Trunk of the pneumogastric nerve placed behind the carotid and internal jugular, which it accompanies throughout their course and is seen between them inferiorly. 9. Hypoglossal nerve. 10. Terminal portion of the same. 11. Its descending branch (descendens hypoglossi nerve). 12. Descending branch from cervical plexus uniting with the preceding (communicans hypoglossi nerve). 13. Plexus or ansa formed by the union of the two preceding nerves. 14. Internal carotid artery. 15. Superior thyroid artery and vein. Lingual and facial arteries arising by a common trunk. 17. Facial artery and vein. 18. Occipital artery. 19. Anterior branches of the fourth pair of cervical nerves. 20. Superior laryngeal nerve.

carotid sheath lies successively upon the longus colli and the rectus capitis anticus major muscles.*

* It is important that we should be aware that the common carotids vary occasionally in their origin. Thus the right may arise in common with the left carotid,

Ligation of Carotid. — The common carotid may be ligatured either above or below the omo-hyoid. It is most accessible above the point where this muscle crosses; and therefore, if the surgeon has his choice, he would prefer to tie the vessel in this situation. In the higher operation we make an incision, three inches (7.6 cm.) in length, along the inner border of the sterno-mastoid, the centre of the incision being opposite the cricoid cartilage; we cut through the skin, superficial fascia, platysma, deep cervical fascia, when we come to the anterior border of the sterno-mastoid. The overlapping edge of this muscle must be drawn outwards, and the muscle at the same time relaxed by turning the head to the same side. The sheath of the vessel is then exposed, and a small opening is to be made on its inner side large enough to admit the aneurism needle, which should be passed round the artery on its outer side, so as to avoid wounding the internal jugular vein. The vessel is then to be ligatured, care being taken not to separate more of the sheath than is necessary from the artery, and not to include in the ligature the pneumogastric or descendens hypoglossi nerves.

Collateral circulation established. — After ligation of the artery, the collateral circulation is maintained by the following vessels: between the branches of the external and internal carotid arteries of the opposite side with the corresponding branches of the ligatured side; between the vertebral and the posterior communicating of the same side; between the inferior and superior thyroids of the same side; between the profunda cervicis and the princeps cervicis of the occipal of the same side.

In what respects the Left Carotid differs from the Right. — In the first part of its course the left carotid differs from the right in the following particulars: —

1. It arises from the arch of the aorta, is therefore longer and deeper seated than the right, and is covered by the first bone of the sternum.

or the right may arise separately from the arch of the aorta, in which case the right subclavian is usually transposed. The left may be given off from the innominate artery of the right side, or it may arise in common with the left subclavian, and thus form a left innominate. In transposition of the aorta there is a left innominate, which is given off first, the right carotid and the right subclavian, arising as separate branches from the arch. The place of division of the common carotid is subject to considerable variation; it may divide higher or lower than usual, the former being the more frequent. Rarely there has been no common carotid artery, the external and internal arising as separate branches from the arch of the aorta.

2. It is crossed by the left brachio-cephalic vein.
3. It is in close relation with the œsophagus and the trachea.
4. It is in close relation with the left recurrent laryngeal nerve.
5. It is in close relation posteriorly with the thoracic duct.
6. It is covered by the thymus gland in early life.

The artery has *in front* the sternum, the sterno-hyoid and sterno-thyroid muscles, the left innominate vein, and the remains of the thymus gland; to the *left side* it has the left subclavian artery and the left pneumogastric nerve; to the *right side* the arteria innominata; and *behind*, the trachea, œsophagus, and thoracic duct.

The common carotid, as a rule, gives off no branch in its course; but, occasionally, the middle sterno-mastoid, the superior thyroid, or, more rarely, the vertebral, arise from it prior to its division. At its bifurcation it usually presents a slight bulbous enlargement, which is sometimes so marked that it might be mistaken for an incipient aneurism. It is necessary to know that the carotid sometimes divides as low as the level of the cricoid cartilage, and that not infrequently the division takes place as high as the hyoid bone.

Internal Jugular Vein. — The internal jugular vein is the continuation of the lateral sinus, and returns the blood from the brain. Leaving the skull through the foramen jugulare, it receives the inferior petrosal sinus, and at the junction it presents a slight enlargement, the *sinus*. The vein descends on the outer side of the internal carotid, and subsequently the common carotid arteries, in the same sheath, and joins the subclavian vein at a right angle to form the brachio-cephalic or innominate vein. In its course down the neck it receives the pharyngeal, occipital, facial, lingual, superior, and middle thyroid veins.

Previous to their terminations the internal jugular veins incline somewhat to the right side to meet the corresponding subclavian veins; thus, on the right side, there is a triangular interval between the artery and vein in which is seen the pneumogastric nerve and vertebral artery; on the left side the vein slightly overlaps the artery, thus rendering ligature of the left carotid more difficult than of the right. The internal jugular veins, moreover, advance slightly to meet the subclavian veins, so that they lie on a plane a little anterior to their accompanying arteries. A little before their termination the internal jugulars have a double valve.

Descendens Hypoglossi and Communicantes Hypoglossi Nerves.—The *descendens hypoglossi* (p. 100) runs down obliquely over the sheath of the carotid to supply the depressor muscles

of the os hyoides. Trace the nerve upwards to see that it leaves the hypoglossal where this nerve curves round the occipital artery. For a short distance the descendens hypoglossi lies within the carotid sheath ; but, about the level of the os hyoides,

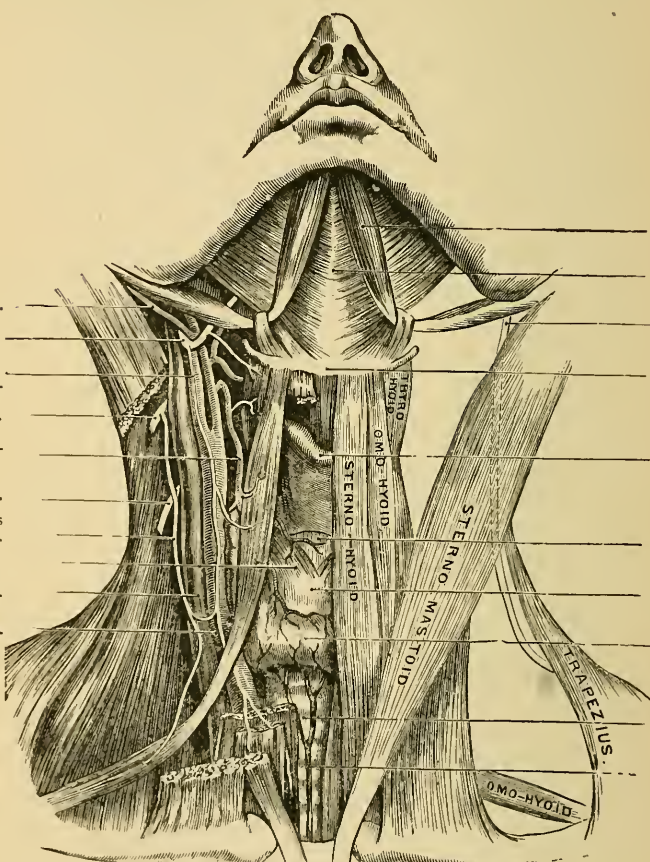


FIG. 39.—CENTRAL LINE OF NECK.—COURSE AND RELATIONS OF COMMON CAROTID ARTERY.

it comes through the sheath, and crosses obliquely over the carotid, from the outer to the inner side. The descendens hyglossi is reinforced by one or more nerves termed *communicantes hypoglossi,* derived from the second and third cervical nerves. These communicating branches descend on the outer side of the internal jugular vein, and form generally two loops

in front of the carotid sheath, constituting a triangular plexus called the "*ansa hypoglossi*." From these loops the nerves proceed to the anterior and posterior bellies of the omo-hyoid to the sterno-hyoid and sterno-thyroid muscles. A small branch may sometimes be traced proceeding from the descendens hypoglossi into the chest to join the cardiac and phrenic nerves.

In some subjects the descendens hypoglossi seems to be wanting, in which case it will probably be concealed *within* the carotid sheath; when this happens the reinforcing loops from the cervical nerves will be found behind the internal jugular vein.*

Dissection. — The thyroid body should now be examined. To expose it, reflect the sterno-hyoid and thyroid muscles from their insertions, so that they can be replaced if necessary. Next observe the lymphatic glands of the neck, and lastly survey the objects in the central line of the neck, from the mandible to the sternum.

Thyroid Body. — This very vascular gland-like body lies over the front and sides of the upper part of the trachea, and extends upwards on each side of the larynx. It consists of *two lateral lobes*, connected a little below the cricoid cartilage by a transverse portion called the *isthmus*, and weighs from one to two ounces (*28.3 gms. to 56.6 gms.*). Each lobe is conical, about two inches (*5 cm.*) in length, and an inch and a quarter (*3.2 cm.*) in breadth. Its base is opposite the fifth or sixth ring of the trachea, and the apex by the side of the thyroid cartilage. Its anterior surface is convex, and is covered by the sterno-hyoid, sterno-thyroid, and omo-hyoid muscles; its deep surface — concave — embraces the sides of the trachea and larynx, and usually extends so far backwards as to be in contact with the pharynx. Its external border overlaps, in most cases partially, but sometimes completely, the common carotid artery, particularly on the right side; and there are instances in which the lobe is deeply grooved by the vessel.

Surgical Landmarks. — The isthmus lies over the second and third rings of the trachea. This portion of the organ varies much in its dimensions. In some instances there is no trans-

* By many anatomists the descendens hypoglossi is regarded as the combination of filaments from the hypoglossal and pneumogastric nerves; by some it is looked upon as a branch of the pneumogastric; and lastly, which is most probable, it is considered by others to be mainly derived from a branch which is sent to the hypoglossal from the first and second cervical nerves.

verse portion. This corresponds with the normal disposition in most of the lower orders of mammalia; but in man, it is a failure in the union of the two halves by which the organ is originally developed.* Generally, the vertical measurement is about half an inch (*13 mm.*). Between its upper border and the cricoid cartilage is a space about one-third of an inch (*8.3 mm.*) in extent, where the trachea is free; this space, therefore, is the more preferable situation for tracheotomy. But the vertical measurement of this isthmus is sometimes of very considerable length, so that it has been seen covering the trachea almost down to the sternum.†

The thyroid body is closely connected, by areola tissue, to the sides of the trachea, to the cricoid and thyroid cartilages. Hence it rises and falls with the larynx in deglutition.

The thyroid varies in size in different individuals and at different periods of life. It is relatively larger in the child than the adult, in the female than the male. In old age it diminishes in size, becomes firmer, and occasionally contains earthy matter.

By far the most notable considerations in respect to the thyroid body are the number, the large size, and the free inosculations of its *arteries*. The superior thyroid arteries come from the external carotid, and enter the front surface of the apex of each lobe; the inferior thyroid come from the subclavian, and enter the under surface of the base. An artery, called the middle thyroid (thyroidea ima), is observed in some subjects; it is given off from the arteria innominata, or the arch of the aorta, and ascends directly in front of the trachea to the isthmus.

Its *veins* are equally large, and form a plexus upon it. The superior and middle thyroid veins cross the common carotid, and open into the internal jugular. The inferior thyroid veins,

* Concerning the development of the lateral halves and central portion of the thyroid body, see a paper by Callender in the *Proceedings of the Royal Society*, 1867.

† From the upper part of the isthmus, or from the adjacent border of either lobe, most commonly the left, a conical prolongation of the thyroid body, called the *pyramid*, frequently ascends in front of the crico-thyroid membrane, as high as the pomum Adami, and is attached to the body of the os hyoides by fibrous tissue. In some subjects we may observe a few muscular fibres passing from the os hyoides to the pyramid. This constitutes the *levator glandulæ thyroideæ* (see preparation in Museum of St. Barth. Hosp., Patholog. Series, No. 14) of some anatomists. There are instances in which the pyramid is double; and, lastly, we have seen a considerable portion of this thyroid substance lying over the crico-thyroid membrane, completely isolated from the rest of the organ. These varieties deserve notice, because any one portion of this structure may become enlarged independently of the rest, and occasion a bronchocele.

two in number, descend over the front of the trachea, communicate freely with each other, and terminate in the left brachiocephalic vein. When you perform tracheotomy, bear in mind the size of these inferior thyroid veins, and the possible existence of a middle thyroid artery.

Its *nerves* are furnished by the middle and inferior cervical ganglia of the sympathetic. They accompany the arteries.

The *lymphatics* of the thyroid body are both numerous and large. They form a dense network on the surface, and pass into the connective tissue of the gland, and eventually "enclose the primary lobes in complete rings or more or less perfect arches." On the right side they open into the right lymphatic duct, on the left side into the thoracic duct.

Structure of the Thyroid Body. — The thyroid body belongs to the class of ductless glands, since no excretory duct has been discovered. It is invested by a thin covering of dense areolar tissue, which connects it with the surrounding structures and also penetrates it, imperfectly dividing it into lobes and supporting the vessels as they enter it. It consists of a multitude of closed vesicles, which are imbedded in a delicate reticulum. The function of the gland is probably that of disintegration of the red blood-cells, and of the conveyance into the general lymphatic system of the products of these degenerative changes.

Relations of the Thyroid in Disease. — An enlargement of the thyroid body is termed a "bronchocele." If the relation of its lobes to the trachea and œsophagus be properly understood, it is easy to predicate the consequences which may result from their enlargement. The nature and severity of the symptoms will, to a certain extent, be determined by the part of the organ affected. An enlargement of the left lobe is more likely to produce a difficulty in swallowing, on account of the inclination of the œsophagus towards the left side. If the isthmus be enlarged, difficulty in breathing will probably be the prominent symptom, and, in order to remove this danger, the isthmus has been divided, and in part removed.

Small lymphatic glands are observed about the thyroid body, especially in front of the trachea; one is often situated over the crico-thyroid membrane. These glands, if enlarged by disease, mlght be taken for a small bronchocele.

Deep Cervical Lymphatic Glands. — In the connective tissue which surrounds the great vessels of the neck, we meet with a series of lymphatic glands, called the deep cervical. They form an uninterrupted chain (whence their name *glandulæ concatenatæ*), from the base of the skull, along the side of the

neck, to the clavicle, beneath which they are continuous with the thoracic and the axillary glands. Some of these glands lie anterior to the common carotid artery; others, between it and the spine. This disposition explains the well-known fact, that, when these glands are enlarged, the great vessels and nerves of the neck are liable to become imbedded in their substance.

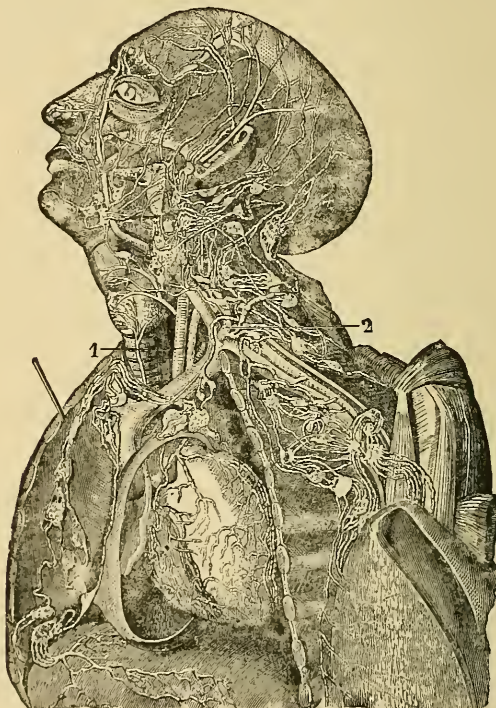


Fig. 40. — Lymphatic Vessels Coming from the Glands of the Neck and Axilla.

1. Superior extremity of the thoracic duct passing behind the internal jugular vein, in an arch. 2. Terminal portion of this arch, which enters in the angle made by the union of the internal jugular and the subclavian veins on the left side.

The glands are particularly numerous near the division of the common carotid, by the side of the pharynx, and the posterior belly of the digastricus. The lymphatics connected with them come from all parts of the head and neck. These vessels unite, to form, on both sides of the neck, one or more absorbent trunks, called the jugular. On the left side this jugular trunk joins the thoracic duct, or opens by a separate orifice into the junction of the left internal jugular and subclavian veins; on the right side it opens into the right lymphatic duct, a short trunk about half an inch in length, which terminates at the angle of the junction of the right internal jugular and subclavian veins. The terminations of the tho-

racic duct and the right lymphatic duct are guarded by two small semilunar valves, in order to prevent regurgitation of blood back from the veins.

The contiguity of the glands to the great vessels and nerves of the neck explains the symptoms produced by their enlargement. The tumor may be so situated as to be raised and depressed by the pulsation of the carotid, and thus stimulate an aneurism. A careful examination, however, will distinguish between an inherent and a communicated pulsation. By grasping the tumor we become sensible that the pulsation does not depend upon any variation of its magnitude, but upon the impulse derived from the artery; consequently, if the tumor be lifted from the vessel, all feeling of pulsation ceases.

Survey of the Central Line of the Neck. — The parts in the central line of the neck should now be well studied (Fig. 39, p. 100). Beginning at the chin, we observe the insertions of the digastric muscles. Below these is the junction, or raphé, of the mylo-hyoid muscles. Then comes the os hyoides. Below the os hyoides is the thyro-hyoid membrane, attached above to the posterior and upper border of the hyoid bone, and below to the thyroid cartilage. Next is the pomum Adami, or projection of the thyroid cartilage, which is apparent between the contiguous borders of the sterno-hyoidei. Below the thyroid cartilage is the cricoid. These two cartilages are connected by the crico-thyroid membrane, across which runs the crico-thyroid artery to join its fellow. Below the cricoid cartilage is the trachea. This is crossed by the isthmus of the thyroid body, and lower down it recedes from the surface, covered by the inferior thyroid veins.

Surgical Relations in Laryngotomy. — Now the chief surgical interest lies just above, and just below, the cricoid cartilage. This cartilage can be felt very plainly in the living subject at any age, no matter how fat. In laryngotomy, the crico-thyroid membrane is divided transversely. The membrane should be divided *close* to the edge of the cricoid c., for two reasons: 1. In order to be farther from the vocal cords. 2. To avoid the crico-thyroid artery, which crosses the middle of the membrane. If more room is required, the cricoid cartilage should be divided longitudinally.

Surgical Relations in Tracheotomy. — In tracheotomy, the trachea may be opened by a perpendicular incision, above the isthmus of the thyroid body, or below it. The operation above the isthmus, if there be space enough for the introduction of the tube, is the easier and safer of the two; for here the trachea is nearer to the surface, and no large blood-vessels are, generally speaking, in the way. The space available measures from a quarter (*6.2 mm.*) to half (*12.5 mm.*) an inch; and

the isthmus is not so firmly adherent to the trachea as to prevent its being drawn downwards for a short distance. However, it is right to state that, in one case out of every eight or ten, there is *no* available space.

Tracheotomy below the isthmus is neither an easy nor a safe operation, for many reasons: 1. The trachea recedes from the surface as it descends, so that just above the sternum it is nearly an inch and a half (*3.8 cm.*) from the skin. 2. The large inferior thyroid veins are in the way. 3. A middle thyroid artery may run up in front of the trachea, direct from the arteria innominata. 4. The arteria innominata itself lies sometimes upon the trachea higher than usual, and may, therefore, be in danger. 5. The left brachio-cephalic vein in some cases crosses the trachea above the edge of the sternum instead of below it.

Whoever pays attention to this subject in the dissecting-room will soon be convinced of the fact that not only large veins, but large arteries, occasionally cross the crico thyroid membrane as well as the trachea, thus showing the necessity of cutting *cautiously* down to, and fairly exposing, the air tube before we venture to open it. It is preferable, after making the first incision through the skin, to lay aside the sharp knife and to use a blunt one, so that the tissues may be torn rather than cut; by this proceeding the liability to hæmorrhage is materially lessened. Tracheotomy is now safely done with the hypodermic injection of a 5 per cent solution of hydrochlorate of cocaine with perfect ease to the patient and little or no danger on account of the hæmorrhage carrying off the surplus of the drug. Ether or chloroform is not necessary.

Dissection of the Submandibular Region or the Digastric Triangle. — When the platysma and the cervical fascia have been removed from their attachment to the mandible, the most conspicuous object is the submandibular gland. Observe that the fascia is here very strong, and forms for the gland a complete capsule. Beneath the mandible are several lymphatic glands, from six to ten in number, of which some lie superficial to the salivary gland, others beneath it. These glands receive the lymphatics of the face, the tonsils, and the tongue.

A little dissection will expose a muscle called the digastric, consisting of two distinct fleshy portions connected by a tendon. They form, with the body of the mandible, a triangle called the *digastric*, of which we propose to examine the contents. The

muscles forming its floor are the mylo-hyoideus and hyo-glossus. Under the submandibular gland is the facial artery, which here runs a tortuous course, and finally turns up over the mandible in front of the masseter muscle. Lying on the mylo-hyoideus, under cover of the mandible, is the submental artery, accompanied by the mylo-hyoid nerve and artery. Behind the submandibular gland, and separating it from the parotid, which also is contained within this triangle, is the stylo-mandibular ligament.

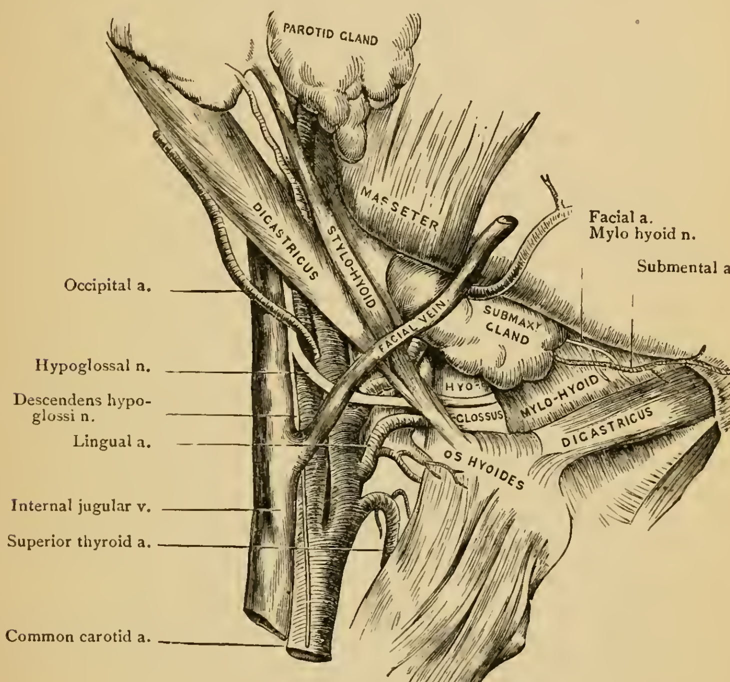


FIG. 41.—DIGASTRIC TRIANGLE AND CONTENTS.

Ascending and then entering the parotid is the external carotid artery, in front of which is the submandibular branch of the facial nerve. Deep in this space are situated the internal jugular vein, the internal carotid artery, and the pneumogastric nerve; and running obliquely forwards between the internal and external carotid arteries are the stylo-glossus, stylo-pharyngeus, glosso-pharyngeal nerve, and the stylo-hyoid ligament.

Digastric.—The *digastric* consists of two muscular bellies

united by an intermediate tendon. The posterior belly *arises* from the digastric fossa of the temporal bone, passes obliquely downwards, forwards, and inwards, and then ascends to be *inserted* by its anterior belly close to the symphysis of the mandible. Raise the submaxillary or *submandibular* gland to see the intermediate tendon of the digastric piercing the stylohyoid muscle, the angle which it forms, and how it is fastened by aponeurosis to the body and the greater cornu of the os hyoides. Observe also that this aponeurosis — *supra-hyoid aponeurosis* — is connected in the mesial line with its fellow of the opposite side, so that a fibrous expansion occupies the interval between the anterior portions of the digastrics.

Action. — The chief action of the digastric is to depress the mandible. But if the mandible be fixed, then the muscle raises the os hyoides, as in deglutition.

The posterior belly of the digastric is supplied by a nerve from the facial; the anterior belly by a branch from the mylohyoidean nerve (which comes from the third division of the fifth pair).

Stylo-hyoideus. — The stylo-hyoideus *arises* from the middle of the styloid process of the temporal bone, and passing downwards and forwards is *inserted* into the body of the os hyoides. This muscle at first runs above the posterior belly of the digastric, and near its insertion is pierced by the digastric tendon. Its nerve is derived from the facial close to its exit from the stylo-mastoid foramen, in common with the branch to the posterior belly of the digastric.* Its *action* is to raise and draw back the os hyoides.

The digastric triangle is bounded above by the horizontal ramus of the mandible, and mastoid process of the temporal bone; behind by the posterior belly of the digastric; and in front by the anterior belly. The objects to be examined in this triangle are twelve in number, as follows: —

1. Submaxillary or *submandibular* salivary gland.
2. Facial vein.
3. Facial artery.
4. Submental artery.
5. Mylo-hyoidean nerve.
6. Submandibular lymphatic glands.
7. Stylo-mandibular ligament.
8. Part of the parotid gland.
9. Part of the external carotid artery.
10. Mylo-hyoideus muscle.
11. Hypoglossal nerve.
12. Part of the hyo-glossus muscle.

* In many, if not in most subjects, a small filament from the hypoglossal nerve is distributed to this muscle.

Submaxillary or *Submandibular* Salivary Gland. — In the ordinary position of the head, the submandibular gland is partially concealed by the mandible, but when the head falls back the gland is more exposed. It is about the size of a chestnut (7 *c. cm.* in volume), weighs about two drachms (*8 gm.*), and is divided into several lobes. Its upper margin is covered by the body of the mandible; its lower margin overlaps the side of the os hyoides. Its cutaneous surface is flat, being covered only by the skin, platysma, and deep cervical fascia; but the lobes on its deep surface are irregular, and often continuous with those of the sublingual gland. By raising the gland we find that it lies upon the mylo-hyoides, the hyo-glossus, the stylo-glossus, the tendon of the digastric, and a portion of the hypoglossal nerve, seen above the tendon. Part of the gland passes beneath the posterior border of the mylo-hyoid, and not infrequently becomes continuous with the sublingual gland. The facial artery lies in a groove on its deeper surface, and subsequently upon its upper border; and it is separated from the parotid gland, which is situated behind it, by the stylo-mandibular ligament. Mark these relations well, because they are of importance, as will be presently explained in tying the lingual artery. (See Fig. 22, p. 58.)

The duct of the gland cannot at this stage of the dissection be traced further, for it runs forward, under cover of the mylo-hyoideus, to end in the floor of the mouth, by the side of the frænum linguæ. The description of its course and relations had better, therefore, be deferred till it can be dissected in its whole length with the gustatory nerve in the pterygoid region.

Facial Vein. — The facial vein does not accompany the facial artery, but runs nearly a straight course. It leaves the face at the anterior edge of the masseter m., then runs *over* the submandibular gland, the digastric and stylo-hyoideus and the carotid artery, to join the internal jugular. This is the rule — but there are frequent exceptions. Before it empties itself into the internal jugular it is joined by a large branch from the external jugular vein. The principal point to remember is, that the vein runs superficial to the gland, and that we must be cautious in opening abscesses under the mandible. (Fig. 38, p. 97.)

Course and Relations of the External Carotid Artery. — The course and relations of the external carotid artery, and its branches in the neck, should now be made out as far as the

parotid gland. In preparing a view of them, observe that nearly all the veins lie *in front* of their corresponding arteries. In removing the connective tissue, fat, and lymphatic glands the student must take care of the nerves and other structures which are liable to be injured.

The *external carotid* arises from the common carotid about the level of the upper border of the thyroid cartilage. It ascends to the interval between the ear and the mandible in a slightly curved direction, at first forwards and then backwards. The external and the internal carotids are in the adult nearly of equal size ; but the external rapidly diminishes in size, owing to the large branches it gives off within a short distance. At first it *lies beneath* the skin, superficial fascia, platysma myoides, deep cervical fascia, some of the superficial cervical nerves, and the sterno-mastoid muscle. It is next crossed by the hypoglossal nerve, the facial and lingual veins, the posterior belly of the digastric and stylo-hyoideus ; it then enters the parotid gland, where it lies beneath the facial nerve and the external jugular vein, and terminates between the external auditory meatus and the neck of the mandible, by dividing into the temporal and internal maxillary arteries. *Internally* the artery is in relation with the hyoid bone, the pharynx, the parotid gland, and the posterior border of the ascending ramus of the mandible.

Behind the external carotid, and separating it from the internal, are the stylo-glossus, the stylo-pharyngeus, the glosso-pharyngeal nerve, and the stylo-hyoid ligament. The superior laryngeal nerve and part of the parotid gland are also placed behind the artery.

Notice the relative position which the external and internal carotids bear to each other. The external lies at first on the same plane with, but nearer to the side of the pharynx than the internal. It soon, however, changes its position, and crosses obliquely in front of the internal to reach the space between the angle of the mandible and the mastoid process. The internal carotid ascends perpendicularly by the *side of the pharynx* to the base of the skull.

The external carotid gives off the following branches : * —

* These may be divided into four sets : those passing forward, or *ventral ;* superior thyroid, lingual, facial ; backward, or *dorsal ;* occipital, posterior auricular ; ascending or *cephalad ;* ascending pharyngeal, and terminal, temporal, internal maxillary. A. H.

1. The superior thyroid.
2. The lingual.
3. The facial.
4. The occipital.
5. The posterior auricular.
6. The internal maxillary.
7. The temporal.
8. The ascending pharyngeal.

Superior Thyroid Artery. — The superior thyroid, the first branch of the external carotid, arises just below the great cornu of the os hyoides. It lies in the superior carotid triangle, and, curving downwards and inwards, runs beneath the omo-hyoid, sterno-hyoid, and sterno-thyroid muscles to the upper and front surface of the thyroid body, in which it terminates. Its branches are the four following: —

1. The *hyoid*, a small muscular branch, runs horizontally inwards below the greater cornu of the os hyoides, and anastomoses with its fellow.

2. The *superior laryngeal* branch, accompanied by the superior laryngeal nerve, runs inwards beneath the thyro-hyoid muscle, pierces the thyro-hyoid membrane (sometimes the thyroid cartilage), supplies the muscles and the mucous membrane of the larynx, and anastomoses with its fellow of the opposite side.

3. The *middle sterno-mastoid*, a small branch, variable as to origin, descends over the sheath of the common carotid artery, and enters the under aspect of the sterno-mastoid muscle.

4. The *crico-thyroid*, an artery of great interest in reference to the operation of laryngotomy, crosses the crico-thyroid membrane, and communicates with a corresponding branch on the opposite side. One or two small branches pass through the membrane to the interior of the larynx. It is important to know that the crico-thyroid artery often varies in direction and size. In most cases it is small, and runs across the centre of the membrane; we should therefore be least likely to wound it in laryngotomy by dividing the membrane close to the cricoid cartilage. But it is by no means infrequent to find this artery of considerable size, taking an oblique or even a perpendicular direction in front of the membrane, and finally distributed to one of the lobes of the thyroid body. We have seen several instances in which the membrane was crossed by the main trunk of the superior thyroid. These facts should establish the practical rule in laryngotomy, not to make an opening into the larynx until it has been fairly exposed.

Among the many arterial inosculations about the thyroid body are two which deserve notice: the one is formed between the two superior thyroid arteries along the upper border of the isthmus; the other takes place along the back part of the lateral lobe between the superior and inferior thyroid arteries of the same side.

The *superior thyroid vein* leaves the upper part of the thyroid body, crosses over the common carotid artery, and joins the internal jugular or the facial vein.

Superior Laryngeal Nerve. — The *superior laryngeal nerve*, mentioned as accompanying the superior laryngeal artery, is given off from the inferior ganglion of the pneumogastric nerve. It descends by the side of the pharynx, behind both carotid arteries, and divides into two branches — the internal and external laryngeal nerves. The *internal branch* enters the larynx through the thyro-hyoid membrane accompanied by the superior laryngeal artery, and supplies the mucous

membrane of the larynx with its exquisite sensibility. Some of its branches may be traced upwards in the aryteno-epiglottidean fold to supply the epiglottis and the base of the tongue; others descend to the rima glottidis; a large branch passes down behind the ala of the thyroid cartilage to join the recurrent laryngeal nerve; and a small branch pierces the arytenoideus to supply the mucous membrane beneath it. The *external branch*, descending beneath the depressors of the larynx, accompanies the crico-thyroid artery, and after distributing filaments to the pha-

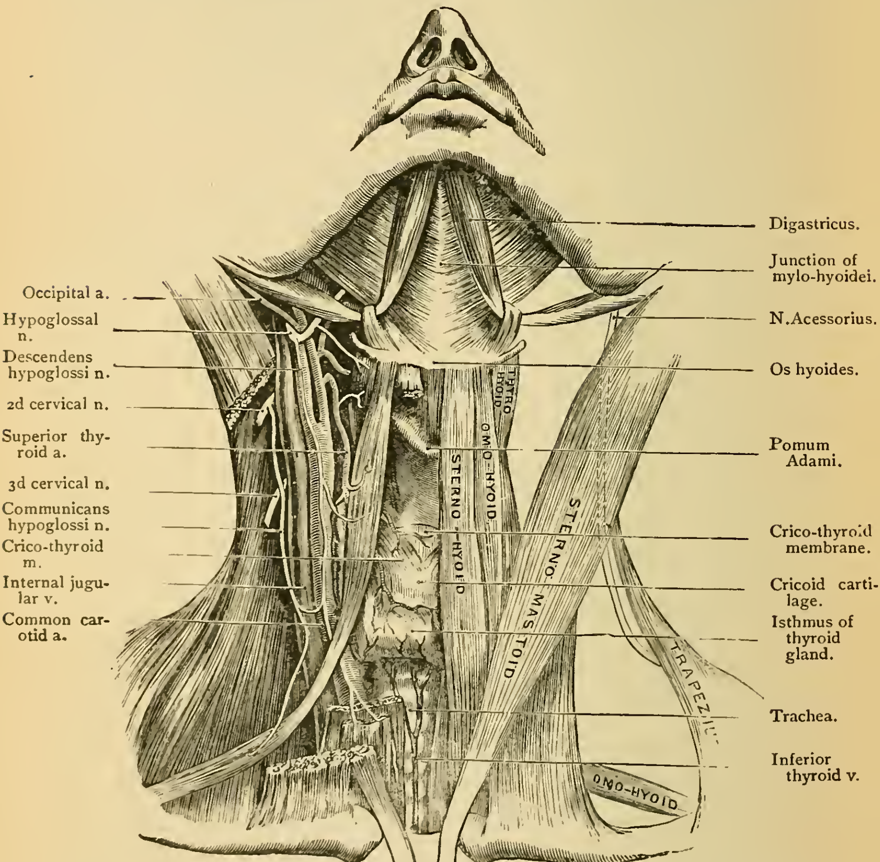


FIG. 42. — CENTRAL LINE OF NECK. — COURSE AND RELATIONS OF COMMON CAROTID ARTERY.

ryngeal plexus, supplies the thyroid body, the inferior constrictor, and the crico-thyroid muscles. It receives a branch from the superior cervical ganglion of the sympathetic, and sends off a cardiac filament to join the superior cardiac branch of the sympathetic behind the common carotid artery.

Lingual Artery. — The lingual artery and its branches will be described in the dissection of the submandibular region.

Facial Artery. — The *facial artery* is the third branch of the external carotid. It runs tortuously *under* the hypoglossal nerve, the posterior belly of the digastric and stylo-hyoideus,

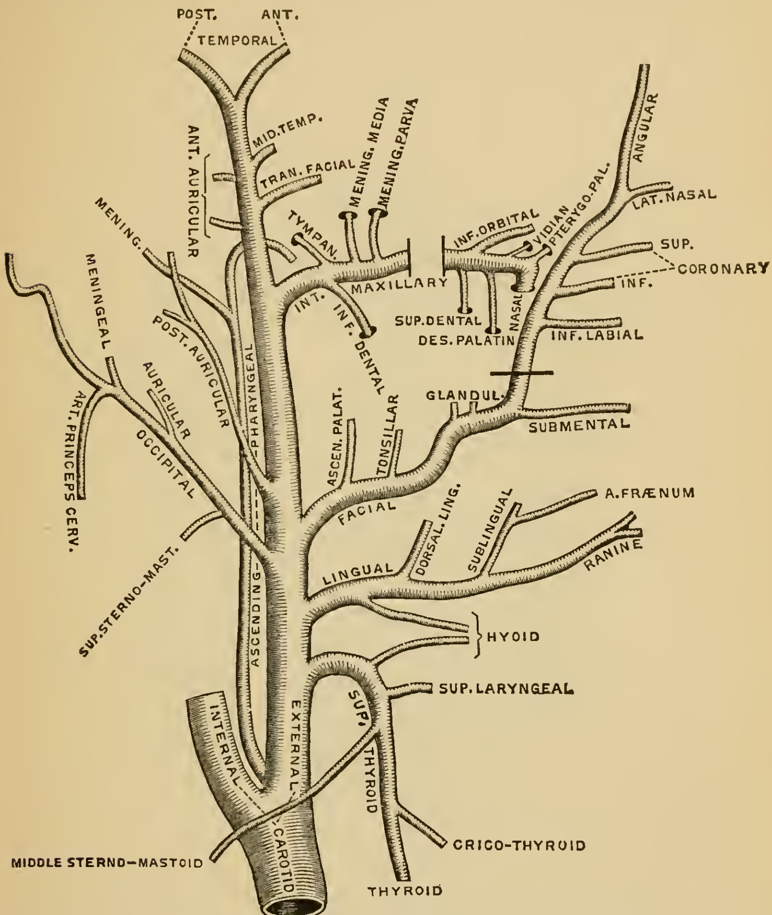


FIG. 43.— DIAGRAM OF THE BRANCHES OF THE EXTERNAL CAROTID ARTERY AND THEIR BRANCHES.

and beneath or through the substance of the submaxillary or *submandibular* gland to the face, where it appears at the anterior border of the masseter. Below the mandible the facial rests on the mylo-hyoideus, and gives off the four following branches:

1. The *ascending* or *inferior palatine artery* runs up between the stylo-glossus and the stylo-pharyngeus m., and behind the internal pterygoid m. to the pharynx, to which and the neighboring parts it gives branches. Ascending as far as the levator palati, it divides into two branches: one courses along the tensor palati to supply the soft palate; the other enters the tonsil, and anastomoses with the descending palatine of the internal maxillary, and with the tonsillar branches of the ascending pharyngeal.

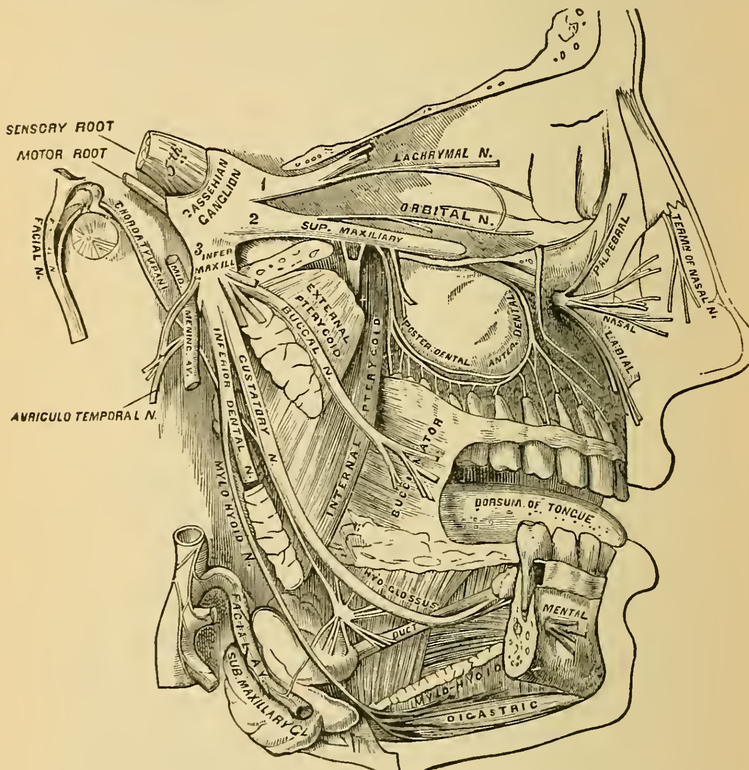


Fig. 44.

2. The *tonsillar* runs up between the internal pterygoid and the stylo-glossus m.; then, perforating the superior constrictor, it supplies the tonsil and root of the tongue.

3. *Glandular* branches to the submaxillary or *submandibular* gland and side of the tongue.

4. The *submental* arises from the facial behind the submaxillary or *submandibular* gland, and runs forwards upon the mylo-hyoideus, beneath the mandible, distributing branches in its course to the gland and the adjacent muscles. It then curves over the bone and divides into two branches: a superficial one, which supplies the skin and lip; and a deep one, which runs between the muscles and the bone, and inosculates with the mental and inferior labial arteries. Beneath the mandible it usually inosculates with the sublingual artery.

The remaining branches of the external carotid artery will be described later on.

Mylo-hyoidean Nerve. — Look for the mylo-hyoidean nerve near the submental artery. The nerve comes from the inferior dental (before its entrance into the dental foramen), and running along a groove on the inner side of the mandible, advances between the bone and the interior pterygoid m., to supply the mylo-hyoideus and the anterior belly of the digastric (Fig. 44).

Submandibular Lymphatic Glands. — The submandibular lymphatic glands receive the lymphatics of the face and the tongue. They are often enlarged in cancerous diseases of the tongue or the lower lip. It should be remembered also that there are lymphatic glands in the mesial line below the chin.

Mylo-hyoideus. — The mylo-hyoideus, a triangular muscle, *arises* from the mylo-hyoid ridge of the mandible from the symphysis, as far back as the last molar tooth (Fig. 41, p. 107). Its posterior fibres are *inserted* into the body of the os hyoides, the anterior being attached to a median tendinous line, termed the *raphé*. Thus the muscles of opposite sides form a muscular floor for the mouth. Superficially, it is in relation with the anterior belly of the digastricus, the submaxillary or *submandibular* gland, the submental artery, and the mylo-hyoidean n. By its deep surface, it is in relation with part of the hyo-glossus, the stylo-glossus, the genio-hyoideus, Wharton's duct, the gustatory and hypoglossal nerves with their communications, and the sublingual gland. It is supplied with nerves by the mylo-hyoid branch of the inferior dental; with blood by the submental artery. The muscles of opposite sides conjointly elevate the os hyoides and the floor of the mouth — as in deglutition.

Stylo-mandibular Ligament. — This is a layer of the deep cervical fascia, extending from the angle of the mandible to the styloid process. It is a broad sheet of fascia, and separates the submandibular gland from the parotid. It is continuous with the fascia covering the pharynx; this gives it a surgical interest, because it prevents accumulations of pus formed near the tonsils and upper part of the pharynx from coming to the surface.

The remaining objects seen in the submaxillary or *submandibular* triangle — namely, the parotid gland, the hypoglossal nerve, the hyo-glossus muscle — will be described presently when they can be better seen. Your attention should now be

directed to a piece of surgical anatomy, which will enable you readily to find and tie the lingual artery. It is this : —

A curved incision, about two inches (*5 cm.*) in length, being made from the lesser cornu along the upper border of the great cornu of the os hyoides, through the skin, the platysma, and the cervical fascia, you will come upon the lower edge of the submaxillary or *submandibular* gland. Lift up the gland, which is easily done, and underneath it you will observe that the tendon of the digastric makes two sides of a triangle, of which the base is formed by the hypoglossal nerve crossing the hyoglossus muscle. Within this little triangle, cut transversely through the fibres of the hyo-glossus : under them is the lingual artery, lying on the middle constrictor. The first time you perform this operation on the dead subject, you will not unlikely miss the artery and cut through the middle constrictor into the pharynx.

Dissection. — The facial vessels must now be divided immediately below the mandible. Reflect the anterior belly of the digastric from its insertion; detach the mylo-hyoideus from the middle line and the os hyoides, and turn it over the body of the mandible, taking care not to injure the muscles and structures beneath. The mandible must now be sawn through, a little to the dissector's side of the symphysis, and the bone drawn upwards by hooks. The tongue should then be drawn out of the mouth, and fastened by hooks. The os hyoides should be drawn down by means of hooks, so as to put the parts on the stretch. All this done, we have to make out, by carefully cleaning away the fat and connective tissue, the following objects represented in Fig. 45, p. 117:

1. Genio-hyoideus.
2. Hyo-glossus.
3. Stylo-glossus.
4. Genio-hyo-glossus.
5. Submandibular duct.
6. Sublingual gland.
7. Hypoglossal nerve.
8. Gustatory nerve.
9. Submandibular ganglion.
10. Lingual artery.

Genio-hyoideus. — The genio-hyoideus *arises* from the inferior tubercle behind the symphysis of the mandible, and passes downwards and backwards to be *inserted* into the front of the body of the os hyoides. This round muscle is situated in the mesial line, parallel to its fellow. Its nerve comes from the hypoglossal, and its blood from the lingual artery. Its action is to draw the os hyoides forwards and upwards; and, if the hyoid bone be fixed, it depresses the mandible.

Hyo-glossus.—The hyo-glossus *arises* from the body, the greater and lesser cornua of the os hyoides, and is *inserted* into the posterior two-thirds of the side of the tongue, its fibres blending with the stylo-glossus and palato-glossus. It is a square and flat muscle, and its fibres ascend nearly perpendicularly from origin to insertion. The fibres arising from the body of the hyoid bone, termed the *basio-glossus*, are directed backwards and upwards, and overlap the fibres which have their origin from the greater cornu and are termed the *kerato-glossus*. Those that arise from the lesser cornu are termed the *chondro-*

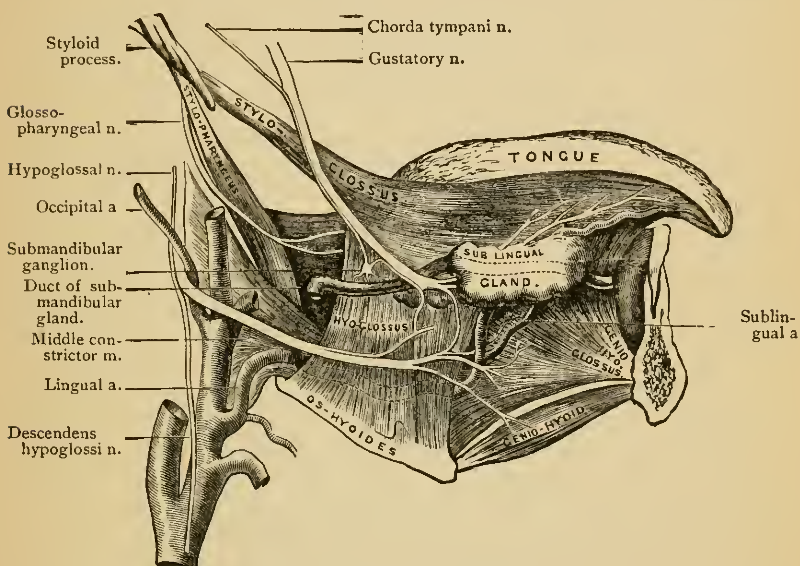


FIG. 45.—MUSCLES, VESSELS, AND NERVES OF THE TONGUE.

glossus. The nerve to the hyo-glossus comes from the hypoglossal, and its blood from the lingual. Its *action* (with that of its fellow) is to depress the tongue. Observe the objects which lie *upon* the hyo-glossus; namely, the hypoglossal and gustatory nerves (which at the anterior border form one or more loops of communication with one another), the chorda tympani nerve, the submandibular ganglion, the submandibular gland and its duct, the hyoid branch of lingual artery, the lingual vein, the sublingual gland, the digastric, stylo-hyoid, stylo-glossus, and mylo-hyoid muscles. *Beneath* the hyo-glossus muscle lie the lingual artery and vein, part of the middle constrictor of

the pharynx, part of the genio-hyo-glossus, the lingualis, and the glosso-pharyngeal nerve.

Genio-hyo-glossus. — The genio-hyo-glossus *arises* by a tendon from the upper tubercle behind the symphysis of the mandible, and is *inserted* as follows: the lower fibres into the body of the os hyoides; the upper fibres into the tongue from the base to the apex. It is the largest and most important of the muscles of the tongue. It is fan-shaped, with the apex attached to the symphysis; thence its fibres radiate into the entire length of the tongue. *Externally*, the muscle is in relation with the stylo-glossus, lingualis, and hyo-glossus, the lingual artery, the sublingual gland, Wharton's duct, the hypoglossal and gustatory nerves; *inferiorly*, by its lower border it is in contact with the genio-hyoid; *above*, by its anterior border, with the mucous membrane of the mouth; and *internally*, it is in contact with its fellow and the fibrous septum of the tongue. It derives its nerves from the hypoglossal, and its blood from the lingual artery. Its *action* is various. The posterior fibres, by raising the os hyoides and drawing forwards the base of the tongue, protrude the tongue out of the mouth; the anterior draw the tongue back again. When every part of the muscle acts, it draws down the whole tongue, and is therefore one of the chief muscles concerned in suction.

Stylo-glossus. — The stylo-glossus, a long and slender muscle, *arises* from the outer side of the styloid process near its apex and from the stylo-mandibular ligament; its fibres pass downwards and forwards, and then nearly horizontal, and are *inserted* along the side of the tongue. It runs outside the hyo-glossus nearly to the tip of the tongue, and blends with the fibres of this muscle, as well as with the palato-glossus. Its nerve comes from the hypoglossal. Its *action* is to retract the tongue.

Hypoglossal Nerve. — The hypoglossal, or twelfth cranial nerve, is the *motor* nerve of the muscles of the tongue. It arises by several filaments, twelve to fifteen, from the front of the medulla between the anterior pyramid and the olivary body. It pierces the dura in two fasciculi which leave the skull through the anterior condylar foramen; these subsequently blend to form a single nerve trunk. It lies deeply beneath the internal jugular vein and internal carotid artery, where it is intimately connected with the lower ganglion of the pneumogastric nerve; it then comes up between the artery and vein, and, immediately below

the posterior belly of the digastric, curves forwards over the occipital, the internal and external carotid, and facial arteries. Next it crosses the hyo-glossus muscle, and passing beneath the mylo-hyoid, divides into branches which supply the following muscles; namely, the stylo-glossus, hyo-glossus, genio-hyo-glossus, lingualis, and the genio-hyoideus.

As it curves round the occipital artery, the hypoglossal nerve sends the *descendens hypoglossi* to the depressors of the os hyoides (p. 117). It also sends a nerve to the thyro-hyoideus, which proceeds from it where it crosses over the external carotid, accompanied by the hyoid branch of the lingual artery. Near the anterior border of the hyo-glossus it communicates by several loops with the gustatory nerve. (Fig. 45, p. 117.)

The hypoglossal at its origin is purely a *motor* nerve. But after leaving the skull, it receives communications from the first two cervical nerves. These communications are important physiologically for two reasons: 1. They account for the hypoglossal nerve containing sensory fibres. 2. They contribute the greater part of the filaments of the descendens hypoglossi. It is also connected by small branches with the pneumogastric nerve and the superior cervical ganglion of the sympathetic at the base of the skull.

Sublingual Gland. — The sublingual gland lies immediately beneath the mucous membrane of the floor of the mouth. Its shape is oblong, with the long axis (about an inch and a half, *3.6 cm.*) directed from before backwards, and it weighs 45 grains (*3 gm.*); its volume is *2.5 c.cm.* Its relations are as follows: *above*, it is covered with mucous membrane; *below*, it rests upon the upper surface of the mylo-hyoid muscle; *internally*, it is in contact with the hyo-glossus, genio-hyo-glossus, stylo-glossus, the gustatory nerve, and Wharton's duct — its length is $1\frac{1}{2}$. inches (*3.8 cm.*), breadth $\frac{1}{12}$ of an inch (*2 mm.*); *posteriorly*, with the submandibular gland; and in *front*, it rests in a depression behind the symphysis of the mandible.

The ducts of the sublingual gland (ducts of Rivinus) vary in number from eight to twenty. They terminate by minute openings behind the orifice of the submandibular duct, along the ridge felt upon the floor of the mouth. One or more ducts terminate in the submandibular duct; one of these takes the name of the *duct of Bartholin.* Its length is a little more than $\frac{3}{4}$ of an inch (*20 mm.*), breadth $\frac{1}{25}$ of an inch (*1 mm.*).

The duct of the submandibular gland may now be traced

across the hyo-glossus, and under the gustatory nerve to the floor of the mouth.

Lingual or Gustatory Nerve. — This nerve is a branch of the mandibular or third division of the fifth pair of cranial nerves. Emerging beneath the external pterygoid muscle, in company with, but in front of, the inferior dental nerve, it rests upon the internal pterygoid muscle. It descends between this latter muscle and the ramus of the mandible, and curves forwards towards the side of the tongue over the superior constrictor of the pharynx, along the upper part of the hyo-glossus, at the anterior border of which it crosses, superficially, the duct of the submandibular gland (Fig. 44, p. 114). Having reached the under part of the tongue, the nerve divides into numerous branches which pierce the muscular structure of the tongue, and then break up into filaments which supply the mucous membrane and the fungiform and filiform papillæ on its anterior three-fourths. Beneath the external pterygoid it is joined at an acute angle by the chorda tympani, a branch of the facial nerve; in its course it gives off some communicating branches to the hypoglossal nerve near the anterior border of the hyo-glossus. It supplies also the mucous membrane of the mouth, gums, and the sublingual gland, one or more branches to the submandibular ganglion, and at the apex of the tongue the terminal branches of this nerve and the hypoglossal are connected.

Submaxillary or Submandibular Ganglion. — At the lower border of the gustatory nerve as it lies upon the hyo-glossus muscle, and before it crosses the submandibular duct, you will find a small, convex, triangular ganglion, about the size of a pin's head. Like the other ganglia in connection with the branches of the fifth pair, it receives filaments of *communication* of three different kinds — viz., motor, sensory, and sympathetic. Its motor root is the chorda tympani, derived from the facial nerve; its sensory branches proceed from the gustatory; and its connection with the sympathetic system is established by a branch which comes from the nervi molles or 8th n. round the facial artery. The ganglion supplies five or six branches of *distribution* to the submandibular gland, its duct, and the mucous membrane of the floor of the mouth. Meckel describes a small branch of the ganglion which sometimes passes forwards to join a branch of the hypoglossal, on the hyo-glossus m., and ends in the genio-hyo-glossus.

Lingual Artery. — The lingual artery is generally the second branch of the external carotid. Curving slightly upwards and inwards from its origin, the artery soon runs forwards round the great cornu of the hyoid bone, beneath the posterior belly of the digastric and stylo-hyoideus, and then passes beneath the hyo-glossus m. parallel to the os hyoides. At the anterior edge of the hyo-glossus it ascends to the under surface of the tongue, and is continued forwards to the apex of the tongue under the name of *ranine*. Before the artery passes beneath the hyo-glossus, it is crossed by the hypoglossal nerve, but it immediately after becomes separated from the nerve by this muscle. Under the hyo-glossus the artery lies upon the middle constrictor of the pharynx and the genio-hyo-glossus; in the substance of the tongue it lies between the genio-hyo-glossus and the inferior lingualis. The curves made by the artery are for the purpose of allowing the elongation of the tongue. Its branches are (Fig. 43, p. 113): —

1. The *hyoid*, a small artery which runs along the upper border of the hyoid bone, supplying the muscles and anastomosing with its fellow, and with the hyoid branch of the superior thyroid artery. The nerve to the thyro-hyoid muscle, which is derived from the hypoglossal, accompanies this artery.

2. The *dorsales linguæ*, two or more, run under the hyo glossus to the back of the tongue, the mucous membrane, tonsil, and soft palate.

3. The *sublingual*, arising near the anterior border of the hyo-glossus, supplies the sublingual gland, the mylo-hyoideus, and the mucous membrane of the mouth and gums. This artery generally gives off the little artery of the frænum linguæ, which is sometimes wounded in cutting the frænum in children who are tongue-tied, especially when we neglect the rule of pointing the scissors downwards and backwards.

4. The *ranine* is the termination of the lingual artery. As it runs forwards to the tip of the tongue along the outer side of the genio-hyo-glossus, along with the gustatory nerve, it distributes branches to the tongue, and at the tip inosculates slightly with its fellow of the opposite side.

The *ranine vein*, commencing at the tip of the tongue, after joining with the venæ comites of the lingual artery and the dorsal veins of the tongue, runs along its under surface *over* the hyo-glossus, and terminates in the internal jugular or facial vein.

The best place for finding and tying the lingual artery has been mentioned (p. 116). The rule laid down is trustworthy only when the artery runs its normal course. We have known an instance in which a good anatomist failed in an attempt to tie the lingual artery, because the vessel arose from the facial behind the submandibular gland, and then passed through the mylo-hyoideus to reach the tongue.

Occipital Artery. — The occipital artery arises from the posterior part of the external carotid, usually opposite the facial artery, and runs upwards and backwards along the lower border of the digastric towards the mastoid process. It passes then under the posterior belly of the digastric, and further on in its course it lies in the interval between the transverse process of the atlas and the mastoid process, close to the rectus capitis lateralis; it now changes its direction, for it runs horizontally backwards in the occipital groove of the temporal bone, under all the muscles attached to the mastoid process — namely, the sterno-mastoid, the splenius capitis, the trachelo-mastoid, and the digastric, and it lies on the superior oblique and the complexus. Arrived at the back of the head, the artery pierces the cranial attachment of the trapezius, and ascending, divides into wide-spreading branches for the supply of the scalp.

In the first part of its course, the occipital artery crosses over the internal carotid artery, the internal jugular vein, the pneumogastric and the spinal accessory nerves, and is itself crossed by the hypoglossal nerve. It sends off the seven following branches: —

1. *Muscular* branches to the digastric, stylo-hyoid, splenius, and trachelo-mastoid muscles.

2. The *superior sterno-mastoid*, which enters the muscles with the nervus accessorius.

3. The *auricular* ramifies on the cranial aspect of the concha.

4. The *posterior meningeal* ascends with the internal jugular vein, and enters the cranium through the foramen jugulare to supply the dura of the posterior fossa.

5. The *princeps cervicis*, which we shall see better hereafter, is a short trunk which runs down the back of the neck, and divides into two branches — a superficial, lying beneath the splenius, and supplying also the trapezius, and a deep branch lying under the complexus, and anastomosing with branches of the vertebral and with the deep cervical branch of the superior intercostal artery between this muscle and the semi-spinalis colli.

6. The *mastoid* enters the foramen in the mastoid process, and supplies the dura.

7. The *cranial* branches supply the scalp on its posterior aspect, and anastomose freely with the corresponding artery of the opposite side, the posterior auricular and the superficial temporal arteries.

The *occipital vein* accompanies the artery, and is connected with the lateral sinus through a small vein running through the mastoid foramen. It subsequently terminates in the internal jugular, occasionally in the external jugular vein.

Posterior Auricular Artery. — The posterior auricular artery (Fig. 43, p. 113), the fifth branch, is given off from the posterior part of the external carotid. It arises above the di-

gastric, lies on the styloid process, and under cover of the parotid gland reaches the furrow between the cartilage of the ear and the mastoid process. Before it reaches the furrow it is crossed by the facial nerve,* and just beneath it is the spinal accessory. Above the mastoid process it divides into two branches, a posterior inosculating with the occipital, and an anterior communicating with the temporal. It supplies the back of the scalp and the cartilage of the ear. It gives off —

1. Small branches of the digastric, stylo-hyoid, and the parotid gland.

2. The *stylo-mastoid*, a very constant little artery, which runs through the stylo-mastoid foramen to supply the mastoid cells, the vestibule, and the membrana tympani. In young subjects, one of these latter branches forms a vascular circle around the circumference of the membrane with the tympanic branch of the internal maxillary.

3. The *auricular* branch runs along the cranial surface of the auricle, and anastomoses with the superficial temporal and occipital arteries. Some of the branches pierce the cartilage of the ear and ramify on its anterior surface.

4. The *mastoid* branch is distributed to the structures over the mastoid process.

The *posterior auricular* vein is rather large, and running over the mastoid process, terminates in the external jugular vein.

Posterior Auricular Nerve. — The posterior auricular nerve lies close to the artery of the same name. It is the first branch of the seventh or facial nerve after its exit from the stylo-mastoid foramen. It runs behind the ear and divides into an *auricular* branch to the retrahens and the attollens aurem, and an *occipital* branch to the posterior belly of the occipito-frontalis, which communicates with the small occipital nerve. The nerve is connected with the great auricular nerve of the cervical plexus, and with the auricular branch of the pneumogastric nerve.

Ascending Pharyngeal Artery. — This long and straight branch arises about half an inch above the division of the common carotid (Fig. 43, p. 113). It ascends between the internal carotid and the side of the pharynx to the base of the skull, lying upon the rectus capitis anticus major. It gives off numerous branches; among them are —

1. *Small external branches* which pass outwards to supply the anterior recti muscles, the superior cervical ganglion, the pneumogastric and hypoglossal nerves, and the prevertebral lymphatic glands. They anastomose with the ascending cervical artery.

2. *Pharyngeal branches*, some of which pass to the two lower pharyngeal constrictors and the stylo-pharyngeus; one, the largest of all, enters the pharynx

* The posterior auricular artery frequently runs superficial to the facial nerve.

above the superior constrictor, and terminates in the soft palate, the Eustachian tube, and the tonsils.

3. *Meningeal or dural branches;* one passes through the foramen lacerum posticum, with the internal jugular vein, and is distributed to the dura of the occipital fossa; another through the foramen lacerum medium, and one through the anterior condylar foramen.

The *pharyngeal vein* receives some dural branches, also small veins from the soft palate, Eustachian tube, and, uniting, form the pharyngeal plexus which opens into the internal jugular or common facial vein.

The examination of the two remaining branches of the external carotid, the internal maxillary and temporal, must for the present be postponed. Meanwhile the student should make out the deep cervical plexus and its branches.

Cervical Plexus of Nerves. — This plexus is formed by the anterior branches of the four upper cervical nerves. It consists of a series of loop-like communications, between these nerves, close to the transverse processes of the four upper cervical vertebræ; each nerve dividing into an ascending and a descending branch, with the exception of the first. The plexus rests on the levator anguli scapulæ and scalenus medius, and is situated behind the sterno-mastoid m. and the internal jugular vein.

The plexus gives off *superficial* and *deep* branches, the superficial coming from the second, third, and fourth nerves, the deep from the third and fourth n. The superficial branches have been already described (p. 81).

The deep branches may be divided into an *internal* and an *external* series.

Internal Series. — 1. The *phrenic* arises from the third, fourth, and fifth cervical nerves, descends obliquely inwards over the scalenus anticus, and then crosses over the first part of the subclavian artery. Near the thorax it is joined by the sympathetic, and frequently by a looped branch from the nerve to the subclavius muscle. Its course through the thorax to its destination in the diaphragm will be described on p. 127.

2. The *communicantes hypoglossi* come from the second and third cervical nerves, wind round the internal jugular vein, and join the descendens hypoglossi in front of the carotid sheath, forming the "ansa hypoglossi." They supply the depressor muscles of the os hyoides and larynx.

3. *Muscular* branches which proceed from the first cervical and the loop between it and the second cervical, to the recti antici, the rectus lateralis, and longus colli muscles.

4. *Branches* which communicate with the pneumogastric, hypoglossal, and sympathetic nerves, and one to join the fifth cervical.

EXTERNAL SERIES. — 1. One or more *communicating branches* to the nervus accessorius: firstly in the sterno-mastoid, then in the occipital triangle, and lastly beneath the trapezius.

2. *Muscular branches* to supply the trapezius, levator anguli scapulæ, scalenus medius, and sterno-mastoid. The branches to the trapezius, levator anguli scapulæ, and scalenus medius, come from the third and fourth; the branch to the sterno-mastoid from the second cervical nerve.

Dissection. — The clavicle should now be sawn through the middle, and the sternal half raised with the sterno-mastoid attached, so that the bone can be replaced, to study its relation to the subjacent parts. The scalene muscles and the sub-clavian artery throughout its whole course must next be carefully dissected. While this is being done, the student must be careful not to injure the branches of the subclavian artery, the lymphatic duct on the right, and the thoracic duct on the left side, the nerve to the subclavius m., the phrenic nerve, the cervical and the brachial plexuses of nerves, and their small branches.

Scalene Muscles. — The scalene muscles, so called from their resemblance to a scalene triangle, extend from the transverse processes of the cervical vertebræ to the first and second ribs. They may be considered as intercostal muscles, since the transverse processes of the cervical vertebræ are but rudimentary ribs. Anatomists describe them as three separate muscles — an anterior, a middle, and a posterior; the anterior and middle are attached to the first rib, the posterior to the second. In plan and purpose these three muscles are one.

Scalenus Anticus. — The scalenus anticus is attached above to the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ, and below by a flat tendon to the tubercle on the *inner* border and upper surface of the first rib in the front of the groove for the subclavian artery.

Scalenus Medius. — The scalenus medius is attached above to the posterior tubercles of the transverse processes of all the cervical vertebræ except the first, and below to the first rib behind the scalenus anticus, extending, from the tubercle, forwards for an inch and a half.

Scalenus Posticus. — The scalenus posticus is attached above to the posterior tubercles of the transverse processes of the two

or three lowest cervical vertebræ, and below to the second rib between its tubercle and angle, anterior to the levator costæ, and behind the serratus magnus.

Nerve-supply to Scalene Muscles. — The scaleni are supplied by branches derived from the lower cervical nerves.

Action of Scalene Muscles. — The scalene muscles are important agents in raising the thorax, in a deep inspiration. Take a deep breath, and you can easily feel them contracting. They can bend the cervical portion of the spine, if their lower attachment be the fixed point, as in rising from the recumbent position.

Relations of Scalenus Anticus Muscle. — The scalenus an-

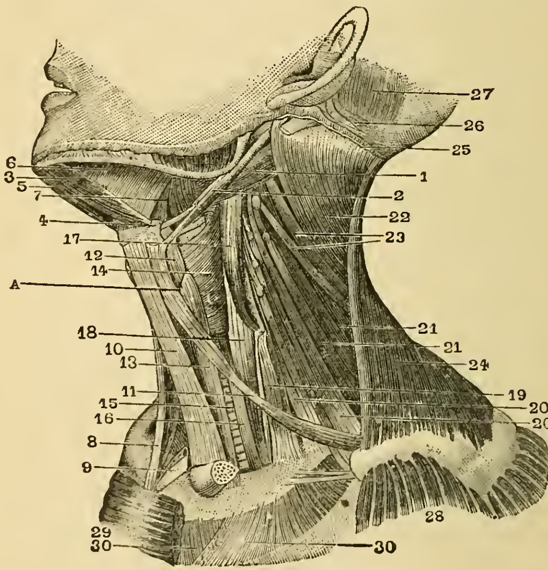


FIG. 46. — SCALENE MUSCLES.

19. Scalenus anticus muscle. 20, 20. Scalenii medius and posticus. 21, 21. Fasciculi of the levator anguli scapulæ muscle. 22. Splenius capitis muscle. 23. Splenius colli muscle.

ticus is one of those muscles about which we ought to know well all that lies in front of it, and all that lies behind it. In the front of it are: the clavicle, the subclavius, the clavicular origin of the sterno-mastoid, the omo-hyoid, the phrenic nerve, the subclavian vein, the supra-scapular, the posterior scapular, and the ascending cervical arteries. Behind it are the subclavian artery, the five nerves which form the brachial plexus, and the pleura ; to its inner side is the internal jugular vein, and the vertebral artery separates it from the longus colli.

Make your finger familiar with the feel of the tubercle on the first rib, to which the scalenus anticus is attached. This tubercle is the guide to the subclavian artery, for it enables you to find the *outer edge* of the scalenus anticus, where you must look for the vessel. Is the scalenus anticus entirely concealed from view by the sterno-mastoid, or not? This will depend upon the breadth of the clavicular attachment of the sterno-mastoid. As a general rule, it may be said that the scalene muscle *is* concealed by the sterno-mastoid, and that consequently, in tying the subclavian artery, it may be necessary to divide partially the clavicular origin of the muscle.

Phrenic Nerve. — The phrenic nerve runs down in front of the scalenus anticus, from the outer to the inner border. It arises from the third, fourth, and fifth cervical nerves, but chiefly from the fourth. It enters the chest between the subclavian artery and vein, crosses in front of the internal mammary artery, and continues its course between the pericardium and pleura, in front of the root of the lung, to the diaphragm, which it supplies.

When the spinal cord is injured above the fourth cervical vertebra, the origin of the phrenic is implicated; therefore, the diaphragm, as well as the other muscles of inspiration, are paralyzed. Death is the immediate result.*

COURSE AND RELATIONS OF THE SUBCLAVIAN ARTERIES.

The left subclavian artery differs from the right, not only in its origin, but in the relations of the first part of its course. The right should, therefore, be examined first, and then the differences between it and the left.

Right Subclavian Artery. — The right subclavian artery is one of the two great branches into which the arteria innominata

* The phrenic nerve is joined by a filament from the sympathetic, and frequently by a filament from that branch of the brachial plexus which supplies the subclavius muscle. This is sometimes a branch of considerable size, and forms the greater portion of the phrenic itself. We have met with many instances in which this accessory branch was larger than the regular trunk; in all of them it crossed over the subclavian artery in the third part of its course, and would probably have been injured in the operation of tying this vessel. That such an accident has actually happened is reported by Bransby Cooper in his surgical lectures. He speaks of having injured this accessory branch of the phrenic in tying the subclavian artery. The patient had incessant spasm of the diaphragm till he died.

divides behind the sterno-clavicular joint. It runs outwards behind the scalenus anticus, then inclines downwards over the first rib, at the outer border of which it takes the name of axillary. The artery describes a curve, of which the greatest convexity is between the scalene muscles. The height to which the arch ascends varies. Generally, it rises higher in women than in men, on the right side than on the left.

To study its relations more precisely, the course of the subclavian is divided into three parts: 1. The part which intervenes between its origin and the inner border of the scalenus anticus. 2. That which lies behind this scalenus. 3. That which intervenes between the outer border of this scalenus and the outer border of the first rib.

The *first* portion of the artery lies deeply in the neck and passes upwards and outwards the inner border of the scalenus anticus. It is *covered* by the skin, platysma, superficial and deep fasciæ, the sternal end of the clavicle, the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles, and a layer of deep fascia, continued from the inner border of the scalenus anticus. It is *crossed* by the internal jugular and vertebral veins, by the pneumogastric and phrenic nerves, and by some cardiac filaments of the sympathetic. *Inferiorly* it rests upon the pleura. *Behind* the artery are the recurrent branch of the pneumogastric, the sympathetic nerve, the longus colli, the transverse process of the seventh cervical vertebra, and the apex of the lung covered with the pleura. The subclavian vein lies below the artery. Three branches arise from this portion of the subclavian — viz., the vertebral, internal mammary, and thyroid axis.

In the *second* (the highest) part of its course, the artery lies between the scalenus anticus and medius muscles. It is *covered* by the skin, platysma, and superficial fascia, by the clavicular origin of the sterno-mastoid, the deep cervical fascia, and by the scalenus anticus and phrenic nerve, which separate it from the subclavian vein. *Behind* the artery is the scalenus medius; *above* it, is the brachial plexus; *below* it, is the pleura. Only one branch, the superior intercostal, is given off from this part of the artery.

In the *third* part of its course, the artery passes downwards and outwards, and lies in the supra-clavicular triangle upon the surface of the first rib. Here it is most superficial, and is *covered* by the skin, platysma, the two layers of the cervical

fascia, and the clavicular branches of the superficial cervical plexus; subsequently by the supra-scapular artery and vein, the clavicle, the subclavius muscle, with its nerve; and, what is of much more consequence, it is here crossed by the external jugular and (often) the supra and posterior scapular veins; so that

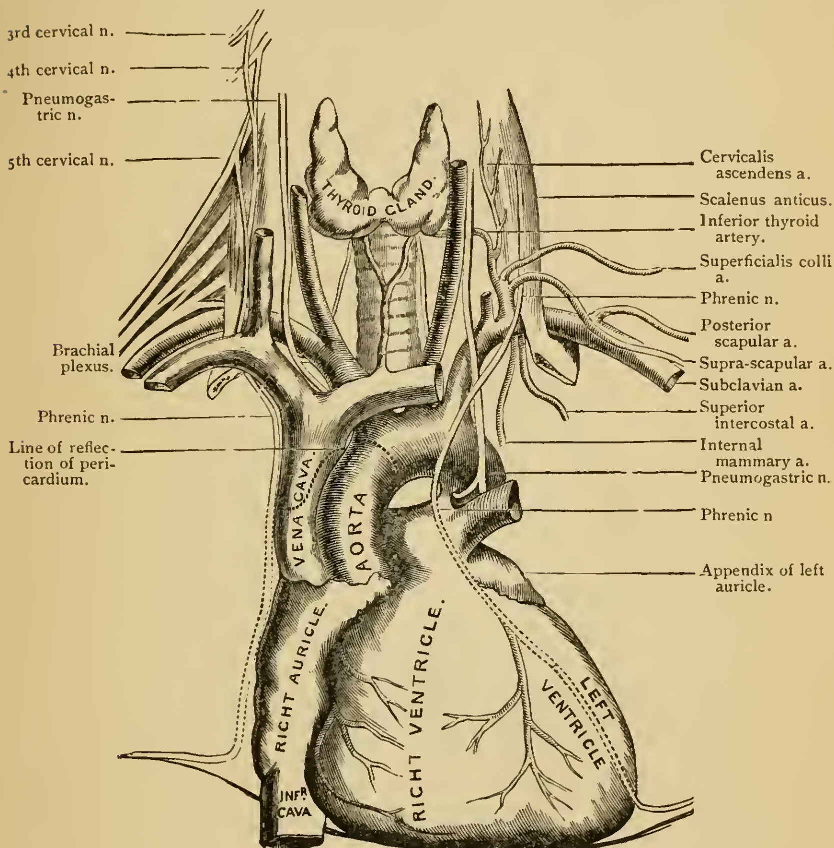


FIG. 47.

there is here a confluence of large veins in front of the artery. The subclavian vein is situated below the artery, but on a plane anterior to it. *Below* it, is the first rib, and behind it the scalenus medius. *Above* the artery, and to its outer side, are the trunk nerves of the brachial plexus and the omo-hyoid m. One of these nerves (the conjoined fifth and sixth cervical) runs so

nearly parallel with the artery, and *on a plane anterior* to it, it is quite possible to mistake the nerve for the artery in the operation of tying the latter. We have heard a hospital surgeon of great experience say that he had seen this mistake committed on three separate occasions. In this part of its course, the artery as a rule gives off no branches; the most frequent exceptions are the posterior scapular and supra-scapular.

Left Subclavian Artery. — The left subclavian is the last of the three great branches which arise from the arch of the aorta. It ascends nearly vertically out of the chest, and then arches in front of the apex of the lung and pleura to reach the inner border of the scalenus anticus, behind which it runs over the first rib.

In the first part of its course the left subclavian lies deeply in the chest near the spine. On its *outer* or left side it is covered by the pleura; on its *inner* or right side are first the trachea, then the œsophagus and thoracic duct; in *front* are the left lung, covered with its pleura, the pneumogastric and phrenic nerves, and the cardiac branches, all of which lie parallel with the artery, the left common carotid, and the left brachio-cephalic vein; at the level of the upper part of the chest it has in front the sterno-thyroid, sterno-hyoid, the sterno-mastoid muscles, the left internal jugular and vertebral veins, and the sternal end of the clavicle; *behind* it are the longus colli, the vertebral column, the inferior cervical ganglion of the sympathetic, the œsophagus, and the thoracic duct.

Behind the scalenus anticus, and on the surface of the first rib, the relations of the left subclavian are similar to those of the right (p. 128).

The left subclavian, then, differs from the right only in the first part of its course. Now, what are these differences?

1. The left subclavian comes direct from the arch of the aorta, and is therefore longer, deeper in the chest, and more vertical than the right, which comes from the arteria innominata.

2. The left subclavian is in close relation with the œsophagus and the thoracic duct: the right is not.

3. The left subclavian is crossed by the left brachio-cephalic vein.

4. The left subclavian has the phrenic, pneumogastric, and cardiac nerves nearly parallel with it; on the right side, these nerves cross the artery at a nearly right angle.

5. The left subclavian is not embraced by the recurrent laryngeal nerve, like the right subclavian.

The thoracic duct bears an important relation to the left subclavian. It ascends from the chest to the left of the œsophagus and *behind* the artery; then arching behind the internal jugular vein as high as the seventh cervical vertebra, it curves

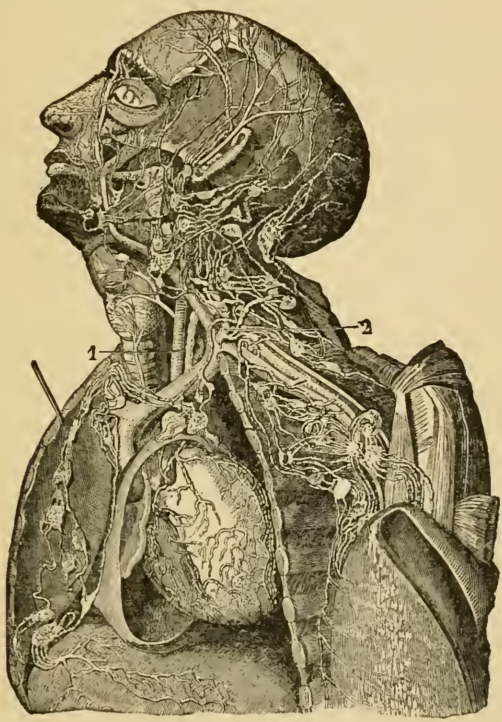


FIG. 48. — LYMPHATIC VESSELS COMING FROM THE GLANDS OF THE NECK AND AXILLA.

1. Superior extremity of the thoracic duct passing behind the internal jugular vein, in an arch. 2. Terminal portion of this arch, which enters in the angle made by the union of the internal jugular and the subclavian veins on the left side.

downwards and forwards in front of the scalenus anticus to terminate in the subclavian vein at its junction with the jugular. The duct is so thin and transparent that it easily escapes observation; it is most readily found by raising the subclavian vein near its junction with the jugular, and searching with the handle of the scalpel on the inner side of the scalenus anticus, in front of the vertebral vein (Fig. 48).

Before tracing the branches of the subclavian artery, consider some points relating to the operation of tying it.

To tie the artery in the first part of its course, namely, on the inner edge of the scalenus anticus, is an operation of great difficulty and danger, even with the parts in a normal position. The great depth at which the artery is placed, the size and close proximity of its numerous branches, the large veins by which it is covered, its connection with the pneumogastric, recurrent laryngeal, phrenic, and sympathetic nerves, and, above all, its close contiguity with the pleura, form a combination of circumstances so formidable that one cannot be surprised the operation has never been performed with a favorable result. On the left side the operation is more difficult to perform than on the right, owing to the difference in the anatomical relation of the two sides.

In the second part of its course, between the scalene muscles, the artery is more accessible, although it is rarely ligatured in this situation. It would be necessary to divide the clavicular origin of the sterno-mastoid, the cervical fascia, and the scalenus anticus to reach the vessel; the phrenic nerve and the subclavian vein would be the chief objects exposed to injury. This operation was performed first and with success by Dupuytren in the year 1819. More recently it has been performed by Dr. Warren, of Boston. The patient recovered, though the pleura was wounded.*

But in the last part of its course, that is, on the outer side of the scalenus, the artery may be tied with comparative facility. The incision should be made from three to four inches (7.5 to 10 c.m.) in length, parallel with the upper border of the clavicle. We divide the platysma, some of the supra-clavicular nerves, and the cervical fascia. The external jugular vein and its tributaries must be drawn to the outer side, or divided and tied at both ends.

The connective tissue should now be carefully cut through, and the posterior belly of the omo-hyoid sought for, as it runs just above the clavicle. After clearing away some fat and cellular tissue, the outer border of the scalenus anticus must be felt for, behind which the artery will be found lying upon the first rib. The operator now passes his finger downwards along the outer border of this muscle, as far as its insertion into the tubercle of the first rib, which can always be distinctly felt. The artery having been exposed by carefully dividing a layer of fascia immediately covering the vessel, the ligature is to be passed round the artery from above downwards, care being taken not to include in the ligature one of the cords of the brachial plexus.

Mr. Ramsden, of St. Bartholomew's Hospital, was the first who tied the subclavian in the third part of its course, in the year 1809; since that time the operation has been repeatedly performed, with very favorable results.

* "Med. Chirurg. Trans.," vol. xxix, p. 25.

In the hands of a surgeon possessed of a practical knowledge of anatomy the operation is easy, provided all circumstances be favorable; but circumstances are often very unfavorable. Anatomical deviations are by no means rare, and it often happens that the aneurismal or other tumor, on account of which the operation is performed, raises the clavicle beyond its natural level, and so disturbs the parts, that to expose the artery and place a ligature around it becomes exceedingly difficult. Under such circumstances one cannot be surprised that even distinguished anatomists have committed mistakes. Sir Astley Cooper * failed in one instance. Dupuytren perforated the artery with the point of the needle, and included one of the nerves in the ligature: fatal hemorrhage was the result.† We were present at an operation in which the large nerve (a branch of the brachial plexus), which runs parallel with and on a plane anterior to the artery, was mistaken for it and tied, the surgeon being deceived by the pulsation communicated to the nerve.

The description of the means whereby the collateral circulation is maintained is deferred until the branches of the subclavian have been made out and described.

Branches of the Subclavian Artery. — The branches of the subclavian extend so widely, that in the present dissection we can trace them only for a short distance. They are four in number: —

1. The vertebral.
2. The thyroid axis, a short, thick trunk which gives off the inferior thyroid, supra-scapular, and posterior scapular.
3. The internal mammary.
4. The superior intercostal, which gives off the deep cervical.

As a rule, the vertebral, the thyroid axis, and the internal mammary are given off from the subclavian in the first part of its course, and the superior intercostal in the second part. The most frequent deviation is, that the posterior scapular (transversalis colli) arises from the subclavian in the third part of its course. On the left side, the superior intercostal is frequently given off in the first part of the course of the subclavian.

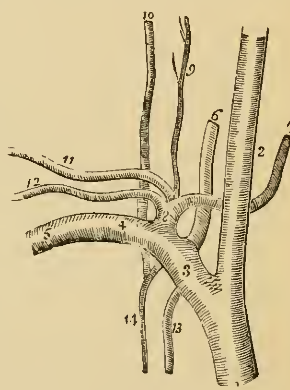


FIG. 49. — BRANCHES OF THE SUBCLAVIAN ARTERY.

1. Innominate artery. 2. Common carotid artery. 3. Subclavian artery. 4, 5. Second and third portions of subclavian artery and commencement of axillary artery. 6. Vertebral artery. 7. Inferior thyroid artery. 8. Thyroid axis. 9. Ascending cervical artery. 10. Profunda cervicis artery. 11. Transversalis colli artery. 12. Supra-scapular artery. 13. Internal mammary artery. 14. Superior intercostal artery.

Vertebral Artery. — This, the first and largest branch, arises from the upper and back part of the subclavian. It

* *London Medical Review*, vol. ii, p. 300.
† *Edinburgh Med. and Surg. Journal*, vol. xvi, 1820.

ascends in the neck, and for a short distance lies in the interval between the scalenus anticus and the longus colli. Here it enters the foramen in the transverse process of the six cervical vertebræ, and ascends through the foramina in the transverse processes of the succeeding vertebræ. In the interval between the axis and the atlas, the artery makes a sigmoid curve, that it may not be stretched in the rotation of the head. Having traversed the foramen of the atlas, the artery curves backwards along the groove in its arch, perforates the posterior occipito-atlantal ligament and the dura, then enters the skull through the foramen magnum, and unites with its fellow near the lower border of the pons to form the basilar artery.

Directly after the artery is given off from the subclavian, it lies behind the internal jugular vein, the inferior thyroid artery, and the vertebral vein, and, on the left side, behind the thoracic duct. As it lies upon the groove on the neural arch of the atlas, it is separated from it by the suboccipital nerve, and is situated within the suboccipital triangle. After it has passed through the foramen magnum, the artery turns round the medulla, and is placed between the hypoglossal nerve and the anterior root of the suboccipital nerve.

The vertebral artery is accompanied by slender nerves from the inferior cervical ganglion of the sympathetic. These nerves communicate with the spinal nerves forming the brachial plexus.

Destined for the brain, the vertebral gives off no branches in the neck, except a few small muscular ones to the deeply seated muscles, and which anastomose with the deep cervical, ascending cervical, and occipital arteries; it furnishes, however, *lateral spinal* branches to the spinal cord and its membranes which pass through the intervertebral foramina.

Each spinal branch divides into two branches; one, passing along the root of the spinal nerve, is distributed to the spinal cord and its membranes; the other ramifies over the posterior surface of the body of the vertebra.

The cranial branches of the vertebral artery are mentioned at length in the description of the arteries of the brain.

The *vertebral vein* is formed by small branches from the muscles near the foramen magnum. It descends in front of the artery through the foramina in the transverse processes, and, emerging through the transverse process of the sixth, crosses the subclavian artery and joins the brachio-cephalic vein, its orifice being guarded by a single or a double valve. It receives

the veins from the neighboring muscles — the dorsi-spinal veins, veins from the spinal canal, the deep and ascending cervical, and the first intercostal veins. In some subjects it communicates with the lateral sinus by a branch through the posterior condylar foramen.

The cervical nerves pass through the intervertebral foramina behind the vertebral artery, so that the artery runs *behind* its vein and in *front* of the nerves.

Thyroid Axis. — The *thyroid axis* arises from the subclavian near the inner edge of the scalenus anticus, and after a course of a quarter of an inch (6.2 mm.) divides into three branches, which take different directions — namely, the inferior thyroid, the supra-scapular, and the posterior scapular.

1. The *inferior thyroid* artery ascends tortuously behind the sheath of the common carotid and the sympathetic nerve, to the deep surface of the thyroid body, in which it communicates freely with the superior thyroid and with its fellow. Besides small branches to the trachea, the œsophagus, and the larynx, it gives off —

The *ascending cervical* artery, which runs up close to the spine, between the scalenus anticus and the rectus capitis anticus major, and terminates in small branches, some of which supply these muscles; others enter the intervertebral foramina, and supply the spinal cord, and its membranes. It anastomoses with the vertebral and ascending pharyngeal arteries.

2. The *supra-scapular* artery (transversalis humeri) runs outwards over the scalenus anticus, covered by the sterno-mastoid m., then directly *beneath* and parallel with the clavicle: crossing over the third part of the subclavian artery, it passes beneath the posterior belly of the omo-hyoid to the superior border of the scapula. Here it is covered by the trapezius, passes *above* the transverse ligament which bridges over the notch; it gives off some branches which ramify in the supra-spinous fossa, and a large communicating branch which passes behind the neck of the scapula to reach the infra-spinous fossa, and inosculates freely in the infra spinous fossa with the dorsalis scapulæ, a branch of the sub-scapular, and with the posterior scapular artery. Near the notch it is joined by the supra-scapular nerve, which runs *through* it. The branches of this artery are numerous but small, and are as follows: the *inferior sterno-mastoid* (p. 87); the *supra-acromial*, which anastomoses with the acromio-thoracic artery; *articular* branches to the shoulder-joint; the *infra-spinous*, which ramifies in the infra-spinous fossa; and the *sub-scapular*, which ramifies in the substance of the sub-scapularis muscle.

3. The *transversalis colli* artery, of which the normal origin is said to be from the thyroid axis, very frequently arises from the subclavian in the last part of its course. It is larger than the preceding artery, and runs tortuously across the side of the neck (higher than the supra-scapular), over the scalene muscles and the great nerves of the brachial plexus (sometimes between them), and divides into two branches, the superficial cervical and the posterior scapular. The *posterior scapular* disappears beneath the trapezius and the levator anguli scapulæ to reach the superior angle of the scapula. It then runs beneath the rhomboid muscles, which it supplies, down to the inferior angle of the scapula, anastomosing freely with the terminations of the supra- and sub-scapular arteries, and with the posterior branches of some of the intercostal arteries. The *superficial cervical* is given off in the space between the sterno-mastoid and trapezius. This vessel proceeds tortuously across the posterior triangle of the neck to the under surface of the trapezius, to which, with the levator anguli scapulæ, it is principally distributed.

The *superficialis colli* often comes direct from the thyroid axis.

The *veins* corresponding to the supra-scapular and posterior scapular arteries terminate in the external jugular, sometimes in the subclavian. The middle thyroid vein crosses in front of the common carotid artery, and joins the internal jugular.

Internal Mammary.— This artery arises from the subclavian opposite to the thyroid axis. It descends slightly inwards behind the clavicle and the subclavian vein, and enters the chest between the cartilage of the first rib and the pleura. It then passes behind the costal cartilages about half an inch (*12.5 mm.*) from the border of the sternum. Its further course will be examined in the dissection of the chest. The corresponding vein, which results from the union of the two venæ comites, most frequently terminates in the brachio-cephalic vein.

Superior Intercostal. — This artery is given off by the subclavian behind the scalenus anticus on the right side, and to its inner side on the left, so that you must divide the muscle to see it. It enters the chest behind the pleura, to the outer side of the first thoracic ganglion of the sympathetic. It runs over the necks of the first and second ribs, and furnishes the arteries of the two upper intercostal spaces, and a posterior branch which is distributed to the muscle of the back and the spinal cord. It usually inosculates with the first intercostal branch of the aorta. The corresponding *vein* terminates on the right side in the vena azygos major; on the left in the brachio-cephalic.

Deep Cervical Artery. — This artery arises from the superior intercostal, seldom direct from the subclavian. It goes to the back of the neck between the first rib and the transverse process of the seventh cervical vertebra, and ascends between the complexus and the semi-spinalis colli, both of which it supplies. It sometimes inosculates with the princeps cervicis, a branch of the occipital (p. 122).

To test your knowledge of the branches of the subclavian artery, reflect upon the answer to the following question: "If the artery were tied in the *first* part of its course before it gives off any branches, how would the arm be supplied with blood?" The answer is, by six collateral channels, as follow: 1. By the communications between the superior and inferior thyroid; 2. Between the two vertebral; 3. Between the internal mammary and the intercostals and the epigastric; 4. Between the thoracic branches of the axillary and the intercostal branches of the aorta; 5. Between the superior intercostal and the aortic intercostals; 6. Between the princeps cervicis and the deep

cervical. Most of these inosculations are shown in the diagram (Fig. 50).

Again, if the subclavian were tied at the *third* part of its course, the circulation would be carried on by the communications: 1. Between the supra-scapular and the dorsalis scapulæ, a branch of the subscapular; 2. Between the supra-acromial branch of the supra-scapular and the acromio-thoracic; 3. Between the posterior scapular and the subscapular and dorsalis scapulæ; 4. Between the internal mammary, the aortic intercostals and superior intercostal, on the one hand, and the long and short thoracic branches of the axillary, on the other.

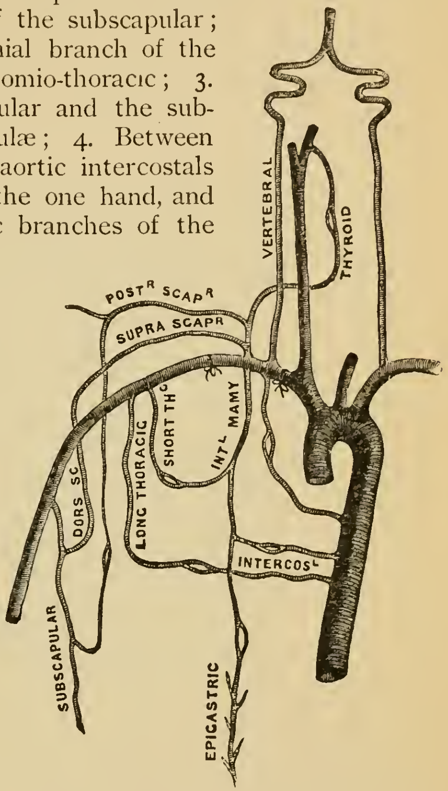


FIG. 50.—DIAGRAM TO SHOW THE INOSCULATIONS OF THE SUBCLAVIAN ARTERY.

Subclavian Vein.—The subclavian vein does not form an arch like the artery, but proceeds in a nearly straight line over the first rib to join the internal jugular. It extends from the outer margin of the first rib to midway between the inner border of the scalenus anticus and the sterno-clavicular articulation, where it joins the internal jugular to form the brachio-cephalic vein. Throughout its whole course the vein is situated on a plane anterior to and a little lower than the artery, from which it is separated by the scalenus anticus, the phrenic and pneumogastric nerves. It has a pair of valves just before its junction with the internal jugular. It receives the anterior jugular, the external jugular, and through it the supra-scapular and posterior scapular veins.

Brachial Plexus of Nerves.—The large nerves forming the plexus which supplies the upper extremity are the anterior divisions of the four lower cervical and the larger portion of the

first thoracic, with a small fasciculus derived from the fourth cervical nerve. Emerging from the intervertebral foramina the nerves appear between the anterior and middle scalene muscles, and pass with the subclavian artery into the axilla. In the neck the nerves have no plexiform arrangement, and it is only in the axilla that they branch and communicate largely with each other, and form the *brachial plexus* of nerves. The nerves in the neck are wide and are situated higher than the subclavian artery, and nearly on the same plane; but as they descend beneath the clavicle, they converge and form large communications with each other, thus constituting the brachial plexus which completely surrounds the artery — one cord lying to the outer side, a second lying to the inner side, and a third behind the vessel.

The plexus is crossed superficially by the omo-hyoid muscle, and by the supra-scapular and posterior scapular arteries, and their corresponding veins.

The arrangement of the nerves in the formation of the plexus is very variable, and often not alike on both sides. The most usual arrangement is that at the outer border of the scalenus anticus the fifth and sixth cervical nerves unite to form an upper trunk; the eighth and the first thoracic n. form a lower trunk; the seventh cervical runs for some distance alone, and forms a middle trunk. Now each of these four upper primary nerves divides into an anterior and a posterior branch: the anterior branches given off from the fifth, sixth, and seventh form the *outer cord* of the plexus; the anterior branches given off from the eighth cervical and first thoracic form the *inner cord;* while the posterior branches of all the nerves (namely, the fifth, sixth, seventh, and eighth cervical) unite to form the *posterior cord.**

The branches arising from the plexus are best arranged into those given off above the clavicle, and those given off below it. The following are those given off *above* the clavicle.

a. The branch forming one of the roots of the phrenic arises from the fifth cervical. (Not in diagram 51 p. 139.)

b. Nerve to the subclavius m. — This proceeds from the fifth and sixth cervical, and crosses the subclavian artery in the third part of its course. It frequently sends a filament, which passes in front of the subclavian vein to join the phrenic nerve.

* Very frequently the posterior branch of the eighth cervical nerve does not, strictly speaking, form part of the posterior cord, but is continued on as a separate fasciculus to form part of the musculo-spiral nerve. For a description of the arrangement of the nerves constituting the plexus, see a paper, by Lucas, *Guy's Hospital Reports* 1875; also Turner, in the *Journal of Anatomy*, 1872.

c. Nerves to the *scaleni* and the *longus colli* muscles are given off from the lower cervical nerves as they leave the intervertebral foramina.

d. Nerve to the rhomboid muscles. — This arises from the fifth cervical nerve, passes through the scalenus medius, and accompanies the posterior scapular artery, beneath the levator anguli scapulæ, which, as well as the rhomboid muscles, it supplies.

e. The *supra-scapular* nerve arises from the cord formed by the fifth and sixth cervical n., runs to the upper border of the

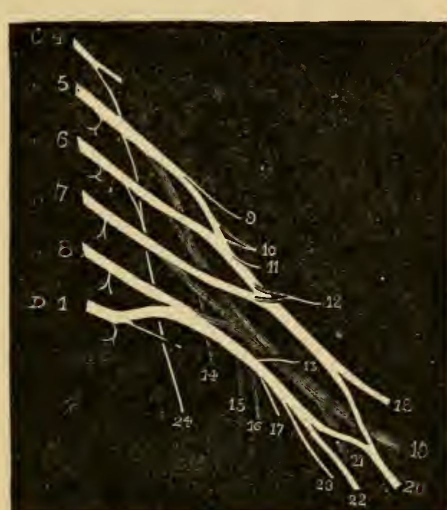


FIG. 51. — DIAGRAM OF THE FORMATION OF THE BRACHIAL PLEXUS AND ITS BRANCHES.
C 4–8. Anterior trunks of the cervical nerves. D 1. Anterior trunk of the first thoracic n. 9. N. to the rhomboid m. 10. Supra-scapular. 11. N. to subclavius m. 12–13. Anterior thoracic. 14, 15, 16. Subscapular n. 17. Lesser int. cutaneous. 18. Musculo-cutaneous. 19. Circumflex. 20. Median. 21. Musculo-spiral. 22. Ulnar. 23. Int. cutaneous. 24. Ext. respiratory of Bell

scapula, where it meets with the corresponding artery, and then passes through the notch in the scapula. In the supra-spinous fossa it gives off two branches to the supra-spinatus m., and an upper articular branch to the shoulder; it then descends behind the acromion process to the infra-spinous fossa, distributing a branch to the infra-spinatus muscle, and a lower articular filament to the shoulder joint.

f. The *posterior thoracic nerve* (called *external respiratory* by Sir C. Bell) to the *serratus magnus* arises from the fifth and

sixth cervical (sometimes also from the seventh) in the substance of the scalenus medius. It passes through this muscle and subsequently emerges below the rhomboid nerve; it then descends behind the brachial plexus and the subclavian vessels to the outer surface of the serratus magnus, to the several digitations of which it is exclusively distributed.

g. An *articular branch* is distributed to the shoulder joint, besides some filaments to the constituent bones.

It only remains to be observed that the upper cord of the brachial plexus receives a branch from the lower cord of the cervical, and that each of its component nerves communicates by slender filaments with the sympathetic.

Below the clavicle the plexus gives off branches for the supply of the arm; namely, from the *outer cord*, the external anterior thoracic (to the pectoralis major), the musculo-cutaneous, and the outer head of the median; from the *inner cord*, the internal anterior thoracic n. (to the pectoralis minor), the inner head of the median, the ulnar, the internal cutaneous, and the lesser internal cutaneous *(nerve of Wrisberg)* nerves; from the *posterior cord*, the three subscapular (to the subscapularis, the latissimus dorsi, and teres major), the circumflex (to the deltoid and teres minor), and the musculo-spiral nerves: all of which will be described more fully in the dissection of the upper extremity.

TEMPORAL AND PTERYGO-MAXILLARY REGIONS.

In this dissection the parts should be examined in the following order:—

1. Superficial and deep fasciæ.
2. Superficial arteries and nerves of the temple.
3. Masseter muscle.
4. Temporal aponeurosis.
5. Temporal muscle.
6. Pterygoid muscles.
7. Internal maxillary artery and branches.
8. Mandibular nerves and branches.

To expose the temporal region, the skin of the temple should be reflected from below upwards. Beneath the skin you come upon a layer of tough connective tissue, continuous, above, with the aponeurosis of the scalp; below, with the fascia covering the masseter and the parotid gland. In this tissue are contained the superficial temporal vessels and nerves.

Temporal Artery. — This is the smaller of the two terminal branches of the external carotid. Arising in the substance of the parotid gland near the neck of the mandible, it passes *over* the root of the zygoma, close to the meatus auditorius externus, ascends for about $1\frac{1}{2}$ inches (*3.8 cm.*) on the temporal fascia, and there divides into an anterior and a posterior branch. Above the zygoma it is superficial, being covered only by the attrahens aurem

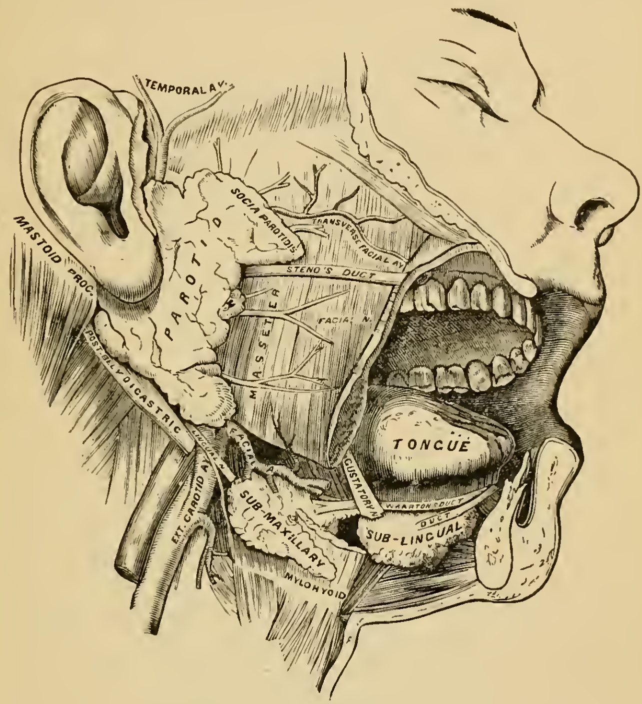


Fig. 52.

and a strong layer of fascia; here it is accompanied by branches of the facial nerve, and by the auriculo-temporal branch of the inferior division of the fifth nerve. It gives off the following branches: —

a. Several *small* branches to the *parotid gland*, the *temporo-mandibular* articulation, and the *masseter*.

b. The *transversalis faciei* (p. 57).

c. The *anterior auricular* branches, two in number, *superior* and *inferior*, ramify on the front of the pinna of the ear, inosculating with branches of the posterior auricular.

d. The *middle temporal*, a small vessel given off while the artery is still in the parotid gland, pierces the temporal fascia above the zygoma, and running in the substance of the temporal muscle anastomoses with the temporal branches of the internal maxillary.

Of the two branches into which the temporal divides, the *anterior* runs tortuously towards the external angle of the frontal bone, distant from it about an inch. Its ramifications extend over the forehead, supplying the orbicularis and occipito-frontalis m., and inosculate with the supra-orbital and frontal arteries. The *posterior* runs towards the back of the head, and inosculates freely with the occipital and posterior auricular. The anterior branch, although the smaller, is usually selected for arteriotomy, the posterior being covered by a strong and unyielding fascia.

The *temporal vein* is formed by the junction of the veins accompanying the terminal branches of the temporal artery, which are situated superficial to the arteries ; just above the zygoma it is joined by the middle temporal vein which takes its origin from a plexus in the temporal fossa. The common temporal vein, formed by the union of these three veins, passes over the zygoma, enters the parotid gland, and joins the internal maxillary vein to form the temporo-maxillary vein.

Auriculo-temporal Nerve. — This nerve supplies the temple and side of the head with common sensation. It arises, close to the foramen ovale, from the third division of the fifth pair by two roots (between which the middle meningeal or *mididural* artery runs). From its origin it proceeds outwards beneath the external pterygoid, between the neck of the mandible and the internal lateral ligament. It then ascends beneath the parotid, over the root of the zygoma, where it accompanies the temporal artery, and divides, like it, into an *anterior* and a *posterior* branch (Fig. 33, p. 83).

The posterior branch is the smaller of the two ; the anterior forms communications with the temporal branches of the facial, and the orbital branch of the maxillary. The ramifications of the nerve correspond with those of the artery.

Near their origin the roots of the nerve are connected by fine filaments with the otic ganglion, and close to the condyle of the mandible the nerve sends round the external carotid artery *two communicating branches* to the temporo-facial branch of the facial nerve. It here distributes *parotid branches* to the gland ; *articular branches* to the temporo-mandibular articulation, to the meatus auditorius and the membrana tympani. Above the zygoma it gives off *two auricular filaments* ; the *upper* ramifies in the skin of the outer aspect of the ear, mainly on the tragus and upper half of the auricle ; the *lower* supplies the lobule and lower part of the pinna.

Lastly, in the subcutaneous tissue of the temple, we find the temporal branches of the facial nerve, which supply the frontalis, the attrahens aurem, the orbicularis palpebrarum, tensor tarsi, and corrugator supercilii.

Masseter Muscle. — This muscle *arises* from the lower edge of the zygoma, and is *inserted* into the outer side of the ramus and coronoid process of the mandible. The masseter is composed of superficial and deep fibres which cross like the letter X. The *superficial* fibres, constituting the principal part of the muscle, arise from the anterior two-thirds of the zygoma by tendinous fibres which occupy the front border of the muscle, and send aponeurotic partitions into its substance. These fibres pass downwards and backwards, this direction giving them greater advantage, and are inserted into the angle and part of the ramus of the mandible. The *deep* fibres, mainly muscular (which are concealed by the parotid gland), arise from the posterior third of the zygoma, incline forwards, and are inserted into the upper half of the ramus and the coronoid process. Besides these, a few fibres, arising from the inner surface of the zygoma, are inserted into the coronoid process and the tendon of the temporal muscle. Its *action* is to raise the mandible and help to masticate the food. Its nerve comes from the mandibular.

The following objects lie superficial to the masseter: 1. Zygomatici major and minor; 2. Orbicularis palpebrarum; 3. Glandula socia parotidis and parotid duct; 4. Transversalis faciei artery; 5. Facial artery and vein; 6. Branches of the facial nerve.

Temporal Fascia. — This strong, shining aponeurotic membrane covers the temporal muscle, its chief use being to give additional origin to its fibres. It is attached above to the temporal ridge, and, increasing in thickness as it descends, divides near the zygoma into two layers, which are attached to the outer and inner borders of the zygomatic arch. These layers are separated by fat, in which is found a filament from the orbital branch of the maxillary nerve, and the orbital branch of the temporal artery. The density of this aponeurosis explains why abscesses in the temporal fossa rarely point outwards; the pus generally makes its way, beneath the zygoma, into the mouth.

Reflect the aponeurosis, and notice that it is separated from the temporal muscle, near the zygoma, by fat. The absorption of this fat, and the wasting of the muscle, occasion the sinking of the temple in emaciation and old age.

Dissection. — Divide the zygomatic arch on each side of the masseter, and turn it downwards, taking care of the masseteric nerve and artery which enter its under aspect. Observe the direction of the superficial and deep fibres, and the tendinous partitions which augment the power of the muscle by increasing its extent of origin. The masseteric nerve and artery enter the under surface of the muscle near to its posterior border, through the sigmoid notch of the mandible; the artery comes from the internal maxillary, the nerve from the motor division of the mandibular.

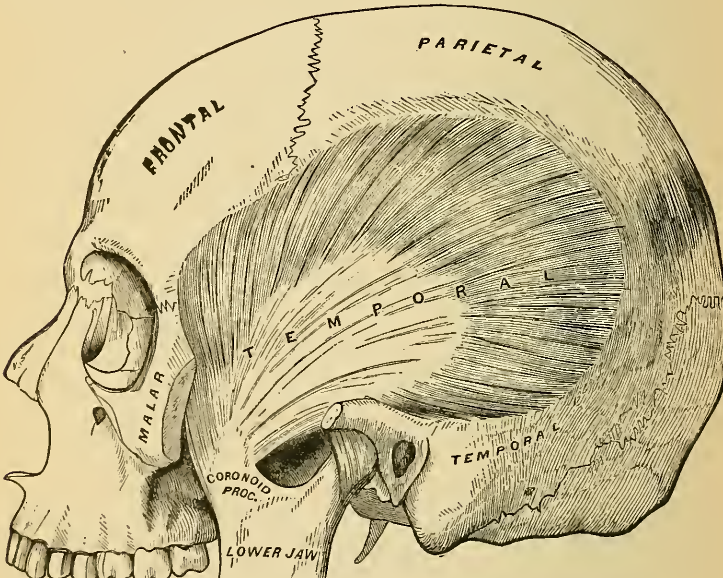


FIG. 53.

Temporal Muscle. — This broad, fan-shaped muscle *arises* from the whole of the temporal fossa (except the malar surface) and the deep surface of the temporal fascia. Its fibres converge to a strong tendon, which is *inserted* into the inner surface, the apex, and anterior border of the coronoid process, as far forwards as the last molar tooth.

The fibres of the muscle, converging from their wide origin, pass under the zygomatic arch, and terminate upon their tendon, the outer surface of which is partially concealed by the insertion of those fibres which come from the temporal aponeurosis :

remove them, and see how this tendon radiates into the muscle like the ribs of a fan. Its *nerves* (two deep temporal) are branches of the mandibular (p. 146).

Between the posterior border of this muscle and the neck of the mandible, the masseteric nerve and artery pass to their destination; in front of the muscle the buccal branch of the mandibular nerve descends to the buccinator with its companion artery.

The temporal muscle is in relation on its deeper surface with the external pterygoid and buccinator muscles, the internal maxillary artery and vein, and the deep temporal arteries and nerves.

Pterygo-maxillary Region. — The zygomatic arch having been already divided, the structures should be cleaned so as to expose the coronoid process of the mandible, the insertion of the temporal muscle, and the loose fat which surrounds it. Next, saw through the coronoid process in a direction downwards and forwards, so as to include the insertion of the muscle, and reflect it upwards without injuring the subjacent vessels and nerves.

Dissection. — To gain a good view of the muscles, nerves, and vessels of the pterygo-maxillary region, a portion of the ascending ramus of the mandible must be removed with a Hey's saw, as shown in Fig. 54, p. 146.

In this region we have to examine the two pterygoid muscles, the trunk and branches of the internal maxillary artery, the mandibular nerve, and the internal lateral ligament of the mandible. All these structures are imbedded in loose soft fat, which must be cautiously removed without injuring them.

External Pterygoid. — This muscle *arises* by two heads, one, the upper, from the great wing of the sphenoid and from the ridge pterygoid; the lower, from the outer surface of the external pterygoid plate, a few fibres taking origin from the outer side of the tuberosities of the palate and maxillary bones. The muscle passes horizontally backwards and is *inserted* into the neck of the mandible, and slightly into the border of the inter-articular fibro-cartilage of the temporo-mandibular articulation. It is supplied by a muscular branch from the mandibular n.

The advantage of the insertion of some of its fibres into the inter-articular cartilage is, that the cartilage follows the condyle in all its movements. When the mandible is dislocated, it is chiefly by the action of this muscle, which draws the condyle

forwards into the zygomatic fossa, the inter-articular cartilage being dislocated with the condyle.

Relations of External Pterygoid.—By its deep surface the muscle is in relation with the internal pterygoid m., the internal lateral ligament, the anteria meningea media or *midi-duralis,* the auriculo-temporal, the gustatory, the inferior dental, and chorda tympani nerves, and occasionally with the internal maxillary artery. Between its two heads of origin the buccal and anterior deep temporal nerves emerge.

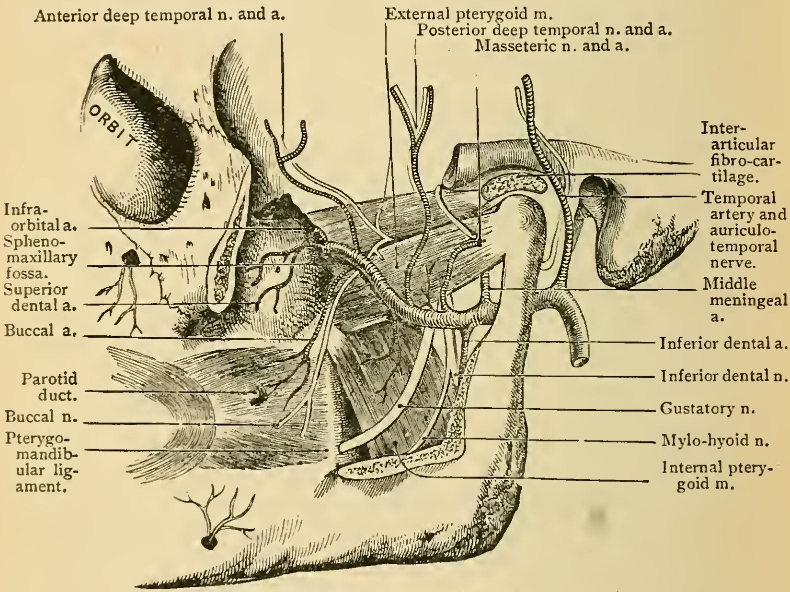


Fig. 54.—Pterygoid Muscles and Internal Maxillary Artery.

Internal Pterygoid.—This muscle *arises* by musculo-tendinous fibres from the inner surface of the external pterygoid plate of the sphenoid bone and from that portion of the tuberosity of the palate bone which forms the lower part of the pterygoid fossa, also by a smaller slip in front of the external pterygoid from the external surface of the tuberosities of the palate and maxillary bones. It is *inserted* into the rough surface on the inner side of the angle of the mandible, as high as the dental foramen. It is supplied by a muscular branch from the mandibular n.

Relations of the Internal Pterygoid. — The internal pterygoid is in relation superficially with the external pterygoid, the internal lateral ligament, the internal maxillary artery and vein, the mandibular vessels and nerve, the mylo-hyoid artery and nerve, the chorda tympani, and the buccal nerves ; by its deep surface, with the tensor palati and superior constrictor muscles.

Notice particularly the direction of the fibres of the pterygoid muscles. The fibres of the external run horizontally outwards and backwards from their origin ; the fibres of the internal run downwards, backwards, and outwards from their origin. The internal pterygoid has tendinous septa like the masseter.

Action of Pterygoid Muscles. — The internal pterygoid raises the mandible, acting in concert with the temporal and masseter muscles ; it moreover assists the external pterygoid and anterior part of the masseter to draw the mandible forwards. The external pterygoid draws the mandible forwards and somewhat to the opposite side, and also in conjunction with the internal pterygoid produces the lateral movements of the mandible essential to the mastication of the food. Consequently they are enormously developed in all ruminants and comparatively feebly in carnivorous animals. The antagonistic muscles of the forward action of the two pterygoids are the temporal m. and the deep fibres of the masseter.

Dissection. — Saw through the neck of the mandible, disarticulate the condyle with its fibro-cartilage from the glenoid cavity, and turn it forwards with the external pterygoid, so that the condyle can be replaced if desirable. A little dissection will bring into view the internal lateral ligament, the internal maxillary artery and vein, the mandibular nerve and its branches, and the chorda tympani nerve.

Internal Maxillary Artery. — This is the larger of the two terminal branches into which the external carotid divides, opposite the neck of the mandible in the parotid gland. It passes horizontally forwards between the neck of the mandible and the internal lateral ligament, then runs tortuously, in some cases above, in others beneath, the external pterygoid, enters the spheno-maxillary fossa between the two heads of the external pterygoid, where it terminates by dividing into numerous branches.

The *course* of this artery is divided into three stages. In the *first*, the artery lies between the neck of the mandible and

the internal lateral ligament; in the *second*, it lies either over or under the external pterygoid; in the *third*, it lies in the spheno-maxillary fossa.

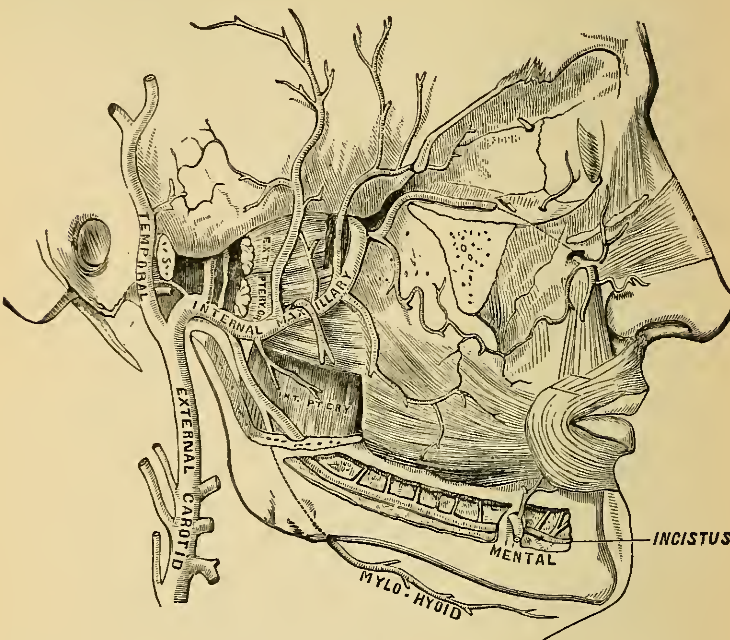


FIG. 55.—INTERNAL MAXILLARY ARTERY.

BRANCHES OF THE INTERNAL MAXILLARY ARTERY IN THE THREE STAGES OF ITS COURSE.

Branches in the First Stage.

a. Tympanic.
b. Meningea (magna) media, or *mididuralis.*
c. Meningea parva, or parviduralis.
d. Mandibular.

Branches in the Second Stage.

Six to the five muscles of mastication, namely:
e. Masseteric.
f. Anterior and posterior deep tempo-al.
g. External and internal pterygoid.
h. Buccal.

Branches in the Third Stage.

i. Superior dental.
j. Infra-orbital.
k. Descending palatine.
l. Vidian.
m. Pterygo-palatine.
n. Nasal or spheno-palatine.

Branches in the First Part.—*a.* The *tympanic* ascends behind the articulation of the mandible, and passes through the Gasserian fissure to the tympanum. It supplies that cavity and the membrana tympani, and anastomoses with the stylo-mastoid and Vidian arteries. It occasionally gives off a *deep auricular* branch which pierces the anterior wall of the external auditory meatus, supplying the skin of this canal. This artery is not infrequently given off from a branch of the internal maxillary artery.

b. The *middle* (*large*) *meningeal* or *mididural* artery ascends between the two roots of the auriculo-temporal nerve, behind the external pterygoid, and enters through the foramen spinosum into the cranium, where it ramifies between the dura and the bones. In the skull it gives off small branches to the Gasserian ganglion, a *petrosal* branch passing through the hiatus Fallopii; *orbital* branches entering the orbit through the sphenoidal fissure; and *temporal* branches which pierce the great wing of the sphenoid to enter the temporal fossa. Its further course is described at p. 33.

c. The *meningea parva* (*small*) or parvidural ascends through the foramen ovale into the skull, and supplies chiefly the ganglion of the fifth cranial nerve. It often comes from the meningea media.

d. The *mandibular* or *inferior dental* artery descends behind the neck of the mandible to the dental foramen, which it enters with the dental or mandibular nerve. It then proceeds through a canal in the diploë to the symphysis, where it minutely inosculates with its fellow. In this canal, which runs beneath the roots of all the teeth, the artery gives branches which ascend through the little

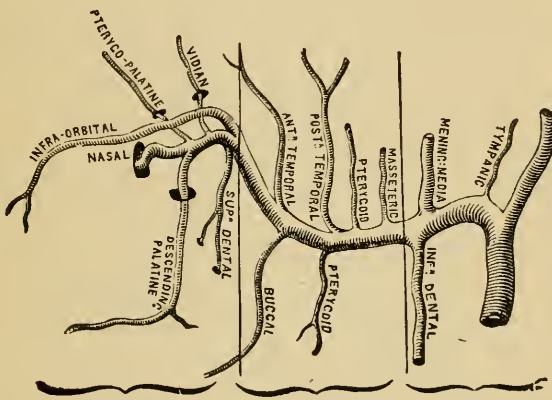


FIG. 56. PLAN OF INTERNAL MAXILLARY ARTERY.

foramina in the fangs, and supply the pulp in their interior. Opposite the foramen mentale arises the mental branch already described (p. 6). Before entering the dental foramen the artery furnishes a small branch — *mylo-hyoid* — which accompanies the nerve proceeding to the mylo-hyoid muscle.

Branches in the Second Part. — *e.* The *masseteric* branch passes through the sigmoid notch of the mandible behind the temporal muscle to the under surface of the masseter, with the masseteric nerve, and inosculates with the facial and transverse facial arteries.

f. The *anterior* and *posterior deep temporal* arteries ascend to supply the temporal muscle, ramifying between the muscle and the bone, one near the front, the other near the posterior border of the muscle. They communicate with the superficial and middle temporal arteries, with the terminal branches of the lachrymal a., and with the temporal branches of the arteria mididuralis.

g. The *pterygoid* branches supply the internal and external pterygoid muscles.

h. The *buccal* branch runs forward with the buccal nerve to the buccinator, where it anastomoses with the facial artery.

Branches in the Third Part. — *i.* The *maxillary* or *superior dental* branch runs along the tuberosity of the maxillary bone, and sends small arteries through the foramina in the bone to the pulps of the molar and bicuspid teeth. It also supplies the gums and the mucous membrane of the antrum.

j. The *infra-orbital* branch ascends through the spheno-maxillary fissure, then runs forward along the infra-orbital canal with the maxillary nerve, and emerges upon the face at the infra-orbital foramen, beneath the levator labii superioris. In the infra-orbital canal the artery sends branches, *anterior dental*, downwards through little canals in the bone to the incisor and canine teeth, and upwards into the orbit to the lachrymal gland, the inferior oblique, and inferior rectus. After issuing from the foramen it sends upwards branches to the lachrymal sac, and descending branches to the upper lip. The former anastomose with the nasal branches of the ophthalmic and facial arteries; the latter with the superior coronary, transverse facial, and buccal arteries.

k. The *posterior descending palatine*, a branch of considerable size, runs down the posterior palatine canal with the palatine nerve (a branch from Meckel's ganglion), and then along the roof of the hard palate, towards the anterior palatine canal, in which, much diminished in size, it inosculates on the septum nasi with a branch of the spheno-palatine artery. It supplies the gums, the glands, and mucous membrane of this part, and furnishes branches to the soft palate.

l. The *Vidian*, an insignificant branch, runs backwards through the Vidian canal with the Vidian nerve, and is distributed to the Eustachian tube, the pharynx, and the tympanum.

m. The *pterygo-palatine* is a small but constant branch which runs backwards through the pterygo-palatine canal with the pharyngeal nerve from Meckel's ganglion, and ramifies upon the upper part of the pharynx and the Eustachian tube.

n. The *nasal* or *spheno-palatine* branch enters the nose through the spheno-palatine foramen in company with the nasal nerve from Meckel's (spheno-palatine) ganglion, and ramifies upon the spongy bones, the ethmoidal cells, and the antrum. One large branch, the *artery of the septum*, runs along the septum nasi towards the anterior palatine canal, where it joins the descending palatine artery.

Observe that all the branches of the internal maxillary artery in the first and third parts of its course traverse bony canals, while the branches in the second part go directly to muscles.

Pterygoid Plexus of Veins. — The *internal maxillary vein* is formed by the veins corresponding to the branches of the artery. As the vein lies between the temporal and external pterygoid muscles it forms a plexus — *pterygoid plexus* — which communicates, above, with the cavernous sinus by branches which come through the foramina at the base of the skull; in front it communicates with the facial vein. It joins the temporal in the substance of the parotid gland, and thus communicates with the external jugular vein.

Mandibular or Third Division of Fifth N. and Branches. — This great nerve is the largest of the three divisions of the fifth cerebral nerve. It differs from the other two divisions, *i.e.*, the ophthalmic and the maxillary, in that it contains motor as well as sensory filaments, the motor being furnished by the small non-ganglionic root of the fifth nerve. It is necessary to remember this point of its physiology in order to understand its exten-

sive distribution; for the sensory portion supplies the parts to which it is distributed with common sensation only, whilst the motor portion supplies all the muscles concerned in mastication.

The nerve, composed of sensory and motor filaments, emerges from the skull through the foramen ovale, into the zygomatic fossa, as a thick trunk, under the name of the mandibular. It lies directly external to the Eustachian tube, and is covered by the external pterygoid muscle, which must be turned on one side to expose it. Immediately after its exit from the skull, the nerve divides into two parts, an anterior, or motor division, and a posterior, or sensory division. From the *anterior* portion (chiefly motor) are derived branches distributed to the muscles of mastication and the buccal nerve. From the *posterior* (mainly sensory) come the following branches: the auriculo-temporal, gustatory, and inferior dental; there are also motor branches to the mylo-hyoid and anterior belly of the digastric. This apparent anomaly will be presently explained.

BRANCHES OF THE MANDIBULAR DIVISION OF THE FIFTH NERVE.

External Portion.	*Internal Portion.*
To temporal muscle.	Auriculo-temporal.
— masseter	Inferior dental.
— external pterygoid.	Gustatory or lingual.
— internal pterygoid.	Mylo-hyoideus.
— buccal.	Anterior belly of digastric.

The *deep temporal branches*, two in number, *anterior* and *posterior*, pass outwards close to the great wing of the sphenoid bone, and ascend with the temporal arteries to the temporal muscle. A *middle temporal* nerve is not infrequently present, and ascends beneath the temporal muscle to enter its deeper aspect. The posterior branch is occasionally joined with the masseteric nerve, the anterior with the buccal nerve.

The branch to the *masseter* runs outwards above the external pterygoid, through the sigmoid notch of the mandible, to the under surface of the muscle.

The branch of the *external pterygoid* comes, apparently, from the buccal nerve in its passage through this muscle.

The branch to the *internal pterygoid* muscle proceeds from the inner side of the main trunk, close to the otic ganglion, and, descending between the internal pterygoid and the tensor palati, enters the inner and deeper aspect of the muscles.

The *buccal* branch, a sensory nerve united at its origin with the anterior deep temporal and external pterygoid nerves, passes either above or between the fibres of the external pterygoid to the buccinator, where it spreads out into filaments, which form

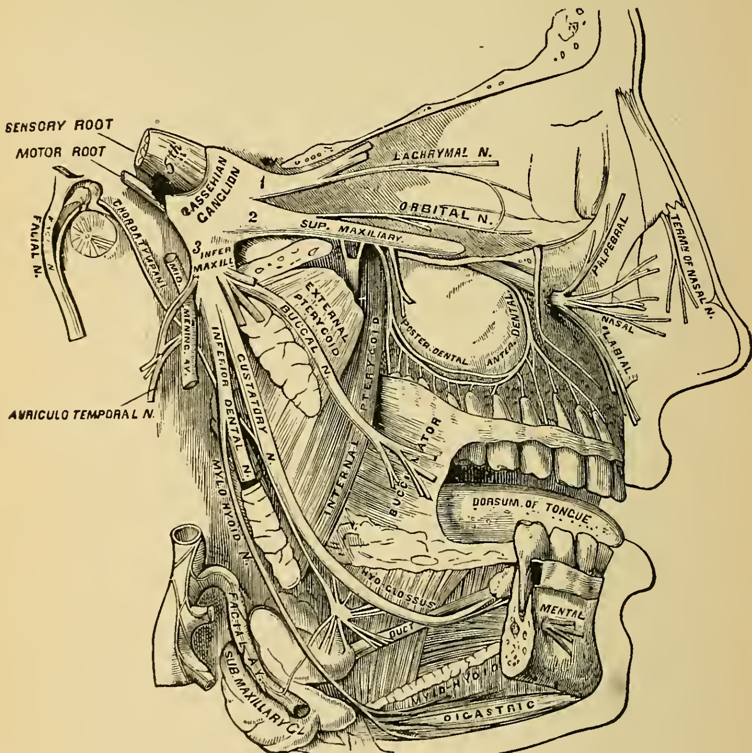


FIG. 57

a plexus with the buccal branches of the facial nerve, and then supply the skin, mucous membrane, and glands of the cheek with common sensation. The motor power of the buccinator, remember, is derived from the facial nerve. That this buccal branch is mainly sensory is proved by the action of the muscle still continuing when the motor division of the fifth nerve is paralyzed. The evidence is corroborated by a case in which this buccal branch proceeded from the second division of the fifth

nerve; no communication being discovered, after very careful dissection, between it and the motor root of the third division.*

The *auriculo-temporal* branch arises by two roots which embrace the middle meningeal artery before it enters the skull. The nerve runs backwards behind the external pterygoid and the neck of the mandible, ascends at first beneath the parotid gland, then over the root of the zygoma with the temporal artery, and divides, like it, into an anterior and a posterior branch. The posterior branch supplies the pinna and surrounding tissues; the anterior is distributed to the skin covering the vertex and temporal region, communicating with the temporal branches of the facial nerve and the orbital branch of the maxillary.

The auriculo-temporal communicates at its origin with the otic ganglion, and then ascends behind the mandible with the temporal branches of the facial n.; it also gives off an *articular branch* to the temporo-mandibular joint; *two branches* to the meatus auditorius and the membrana tympani; *parotid branches* to the gland; *auricular branches*, two in number—an *inferior*, which is distributed to the ear below the auditory meatus, and a *superior* to the tragus and auricle. Its branches have been described (p. 23).

The *inferior dental* branch emerges beneath the external pterygoid, and descends between the ramus and the internal lateral ligament of the mandible to the dental foramen, which it enters with the dental or mandibular artery. It then runs in the canal in the diploë of the mandible, and furnishes filaments which ascend through the canals in the fangs of the teeth to the pulp in their interior. Opposite the foramen mentale it divides into two branches, the *mental* and the *incisor*. Observe that the same nerve which supplies the teeth supplies the gums; hence the sympathy between them.

a. The *mylo-hyoid* branch, apparently arising from the dental, is derived from the motor root of the fifth, and may, with careful dissection, be traced to it. It leaves the sheath of the dental nerve near the foramen in the mandible, and runs in a groove on the inner side of the ramus to the lower surface of the mylo-hyoid, which muscle it supplies together with the anterior portion of the digastric.

b. The *dental* branches pass upwards to the fangs of the molar and bicuspid teeth.

c. The *incisor* branch is the continuation of the nerve, and passes to the symphysis, supplying the canine and incisor teeth.

d. The *mental* branch (sometimes called *labial*) emerges through the foramen

* Turner, "On the Variation of the Buccal Nerve." *Journal of Anat. and Phys.*, No. I., 1866.

mentale, and soon divides into numerous branches; some ascend to the lower lip beneath the depressor labii inferioris, and communicate with the facial nerve; others pass inwards to the skin of the chin.

The *gustatory* or *lingual nerve* lies at first behind the external pterygoid m., then descends obliquely forwards between the ramus of the mandible and the internal pterygoid m., and subsequently for a short distance between the mandible and the superior constrictor of the pharynx. Here it lies close under the mucous membrane of the mouth near the last molar tooth of the mandible. Division of it in this situation relieves pain in cancer of the tongue. The gustatory n. then rests upon the stylo-glossus and the hyo-glossus m., and after crossing Wharton's duct passes to the tip of the tongue.

The nerve at first lies in front of the mandibular nerve (with which it is frequently connected), and beneath the internal maxillary a. Beneath the external pterygoid, the gustatory n. is joined at an acute angle by the *chorda tympani* (a branch of the facial). This branch emerges through a small canal, *canal of Huguier*, by the side of the Gasserian fissure, and passing behind the dental n., meets the gustatory, and runs along the lower border of this nerve to supply the submandibular gland; part of it joins the submandibular ganglion, and it is then eventually distributed to the lingualis muscle.

The gustatory nerve in its course gives off —

a. Communicating branches to the hypoglossal n., forming two or more loops at the anterior border of the hyo-glossus muscle.

b. Communicating branches to the submaxillary ganglion.

c. Branches to the mucous membrane of the mouth, gums, and sublingual gland.

d. Lingual branches which pass to the papillæ of the sides and tip of the tongue; here also we find communications between this nerve and the hypoglossal.

The duct of the submaxillary or *submandibular* gland (p. 109), *Wharton's duct*, can now be traced to its termination. It passes from its under surface, runs forwards under the mylo-hyoideus and upon the hyo-glossus muscle; it then passes beneath the gustatory nerve, and subsequently runs between the sublingual gland and the genio-hyo-glossus, to open into the floor of the mouth, by the side of the frænum linguæ. Its length is about two inches (*5 cm.*); its dimensions are not equal throughout; it is dilated about the middle, and contracted at the orifice. Saliva, collected in the dilated portion, is sometimes spurted to a considerable distance out of the narrow orifice, in consequence of the sudden contraction of the neighboring muscles.

The gland is supplied with nerves by branches from the submandibular ganglion, from the sympathetic, and the mylo-hyoid nerves.

In the floor of the mouth there occasionally exists a cystic tumor, called a *ranula*, with semi-transparent walls, perceptible beneath the tongue. By some of the older writers it was looked upon as an abnormal dilatation of the submandibular duct. There is, however, no reason for believing this swelling (except very rarely) to be connected with the duct. It is rather a cyst formed in the loose areolar tissue under the tongue, or is an enlargement of one of the small bursæ which normally exist in this situation. The character of the saliva presents no agreement with the fluid contained in these cysts, which is thickly glairy, like the white of an egg.

Internal Lateral or Spheno-mandibular Ligament. — This so-called ligament (which is more like a layer of fascia) passes from the spinous process of the sphenoid bone to the inner side of the foramen dentale. Between this ligament and the neck of the mandible we find the internal maxillary artery and vein, the auriculo-temporal nerve, the middle meningeal artery, the mandibular nerve and artery, and a portion of the parotid gland.

At this stage of the dissection you will be able to trace the course and relations of the internal carotid artery. But before doing this, examine the several objects which intervene between the external and internal carotids. These are: 1. The stylo-glossus; 2. The stylo-pharyngeus; 3. The glosso-pharyngeal nerve; 4. The stylo-hyoid ligament.

Stylo-glossus. — This *arises* from the front of the styloid process near the apex, and from the stylo-mandibular ligament. It passes at first downwards and then horizontally forwards, and is *inserted* along the side of the tongue as far as the tip, some of its lower fibres decussating with those of the hyo-glossus. Its *action* is to retract the tongue. Its *nerve* is a branch of the hypoglossal.

Stylo-pharyngeus. — This *arises* from the inner side of the styloid process near the base, and is *inserted* into the upper and posterior edges of the thyroid cartilage. It descends along the side of the pharynx between the superior and the middle constrictors; some of its fibres blend with the constrictor muscles; others join those of the palato-pharyngeus at its insertion. Curving round its lower border is seen the glosso-pharyngeal

nerve, from which its nerve-supply is derived. Its *action* is to raise the larynx with the pharynx in deglutition.* (See Fig. 89.)

Between the stylo-glossus and stylo-pharyngeus, and nearly parallel with both, is the *stylo-hyoid ligament.* It extends from the apex of the styloid process to the lesser cornu of the os hyoides. It is often more or less ossified.

The *ascending palatine artery*, a branch of the facial (p. 114),

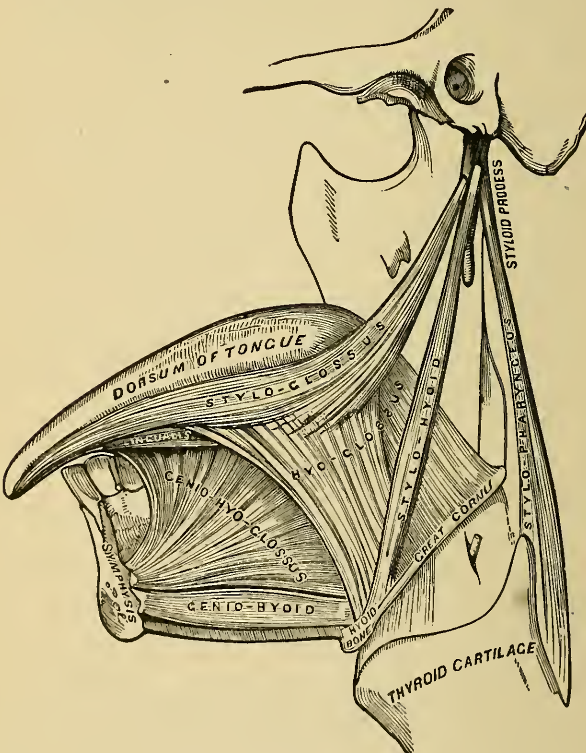


FIG. 58.

runs up between the stylo-glossus and the stylo-pharyngeus, and divides into branches which supply these muscles, the palate, the side of the pharynx, and the tonsils. It inosculates with the descending palatine, a branch of the internal maxillary.

Glosso-pharyngeal Nerve. — The glosso-pharyngeal nerve

* Varieties of this muscle are frequently met with, chiefly as supernumerary muscles. They arise variably from neighboring parts of the base of the skull close to the styloid process, and are inserted either into the pharyngeal constrictors or into the aponeurosis of the pharynx.

is observed curving forwards round the lower border of the stylo-pharyngeus (p. 155). It is the ninth cranial nerve, arises by five or six filaments from the groove between the olivary body and the restiform tract of the medulla, leaves the skull through the middle part of the foramen jugulare in a separate sheath of dura, in front of the pneumogastric and spinal accessory nerves, and descends between the internal jugular vein and the internal carotid artery. It then crosses in front of the artery below the styloid process, and proceeds along the lower border of the stylo-pharyngeus. At this point it curves forwards over that muscle and the middle constrictor of the pharynx, and disappears beneath the hyo-glossus, where it divides into its terminal branches, which supply the mucous membrane of the pharynx, the back of the tongue, and the tonsils.

The glosso-pharyngeal is, at its origin, purely a sensory nerve. But soon after its exit from the skull it receives *communications* from the facial, the pneumogastric, and the sympathetic, so that it soon becomes a compound nerve — *i.e.*, composed of both sensory and motor filaments. At the base of the skull it presents two ganglia — the *jugular* (*ganglion of Ehrenritter*), which has no branches, and the *petrous* (ganglion of Andersch). The branches given off by the petrous ganglion will be dissected hereafter;* at present the student can only make out the branches which this nerve gives off in the neck, namely: —

Carotid branches, which surround the internal carotid artery as far as its origin, and communicate with the pharyngeal branch of the pneumogastric and with the sympathetic.

Pharyngeal branches, three or four in number, which form by the side of the middle constrictor of the pharynx, a plexus, the pharyngeal plexus, supplemented by filaments derived from the pneumogastric, the nervus accessorius, the external laryngeal, and the sympathetic. Its branches supply the constrictor muscles and the mucous membrane of the pharynx, the back of the tongue, and the tonsils.

Muscular branches which enter the stylo-pharyngeus m.

Tonsillar branches which are given to the soft palate and the fauces, and to the tonsils forming a plexus [circulus tonsillaris].

Lingual branches, two in number, which are distributed to the base and lateral aspects of the tongue: one branch turns upwards and is distributed to the papillæ circumvallatæ, and the mucous membrane of the posterior third of the tongue as far backwards as the epiglottis; the other passes to the middle of the side of the tongue communicating with the gustatory nerve.

The styloid process must now be cut through at its base, and turned forwards with the muscles arising from it. The internal carotid artery will thus be exposed in the cervical region, as far

* P. 274.

as the carotid canal. The part of the artery contained within the carotid canal will be described hereafter.

Internal Carotid Artery. — The *internal carotid artery* proceeds from the bifurcation of the common carotid at the upper border of the thyroid cartilage, and ascends vertically to the base of the skull *by the side of the pharynx*, in front of the transverse processes of the three upper cervical vertebræ. It enters the skull through the carotid canal in the temporal bone, runs tortuously by the side of the body of the sphenoid, and terminates in branches which supply the orbit and the brain. It is divided into four portions — the cervical, petrous, cavernous, and cerebral. In the *cervical part* of its course it is situated immediately to the outer side of the external carotid artery, behind the inner border of the sterno-mastoid. It soon gets beneath the external carotid, and lies deeply beneath the parotid gland, and ascends by the side of the pharynx. It *lies upon* the rectus capitis anticus major, the superior laryngeal nerve, and the superior cervical ganglion of the sympathetic; to its *outer side* is the internal jugular vein and the pneumogastric nerve; to its *inner side* is the pharynx; the superior constrictor muscle separates it from the tonsil, and the ascending pharyngeal artery; it is *crossed*, successively, by the hypoglossal nerve, the occipital artery, the digastric, and stylo-hyoid, muscles; higher up it is crossed by the styloid process, the stylo-glossus, and stylo-pharyngeus muscle, by the glosso-pharyngeal nerve and the stylo-hyoid ligament, all of which last-named structures intervene between it and the external carotid,

The most important relation of the artery, in a surgical point of view, is that it ascends close by the *side of the pharynx tonsil.** In opening an abscess, therefore, near the tonsil, or at the back of the pharynx, be careful to introduce the knife with its point inwards towards the mesial line; observe this caution the more, because in some subjects the internal carotid makes a curve, or even a complete curl upon itself, in its ascent near the pharynx. In such cases an undue deviation of the instrument in an outward direction might injure the vessel.

Ascending Pharyngeal Artery. — This artery generally

* As the interval between the artery and the tonsil is considerable, as can be shown by horizontal section, it is not likely, except in the hands of a bungling operator, that the artery can be punctured, but as the arterial anastomoses is profuse, considerable hæmorrhage may result in the old knife operation for removal of part of the tonsil, but with the guillotine this is avoided. — A.H.

arises from the back part of the external carotid about half an inch (*12.5 mm.*) above the angle of the common carotid. It ascends in a straight course between the internal carotid artery and the side of the pharynx, towards the base of the skull, resting upon the rectus capitis anticus major. It gives off three sets of branches: —

a. Pharyngeal branches, three or four in number: the two lower supply the inferior and middle constrictors, and stylo-pharyngeus, anastomosing with the superior thyroid a.; the upper branch, the *palatine*, ascends upon the superior constrictor, runs down with the levator palati, above the superior constrictor, and supplies the muscles of the palate, the Eustachian tube, and the tonsil.

b. Prevertebral branches, which supply the prevertebral muscles, the superior cervical ganglion of the sympathetic, the lymphatic glands, and the pneumogastric and hypoglossal nerves.

c. Meningeal branches, which supply the dura; passing through the foramen lacerum medium, the anterior condylar foramen, and the foramen jugulare with the internal jugular vein.

Pneumogastric Nerve or Tenth N. — The *pneumogastric nerve* is the tenth cranial nerve, and has the longest course of all the cerebral nerves. It arises from the medulla by a series of roots, from twelve to fifteen in number, from the front of the restiform body. It passes out of the skull in a common sheath of dura and arachnoid, with the nervus aceessorius through the foramen jugulare. It is a sensory nerve at its commencement, but afterwards is a mixed n.

Within the foramen jugulare a small ganglion — *ganglion of the root* (Arnold's ganglion) — about one-sixth of an inch (*4 mm.*) in length, is situated upon the pneumogastric nerve, and is joined by a branch from the nervus accessorius. This ganglion will be described hereafter. About half an inch (*12.5 mm.*) below the preceding the pneumogastric nerve swells out, and forms a second ganglion — *ganglion of the trunk* — (inferior ganglion), of a reddish-gray color. This ganglion occupies about an inch (*2.5 c.m.*) of the nerve, but does not involve the whole of its fibres, the branch from the spinal accessory joining the pneumogastric below the ganglion. It is united to the hypoglossal nerve, from which it receives filaments; it also receives filaments from the first and second spinal nerves, and from the superior cervical ganglion of the sympathetic.

Thus, the pneumogastric, at its origin probably a nerve of sensation only, becomes, in consequence of the connecting filaments from these various branches, a compound nerve, and in all respects analogous to a spinal nerve.

Leaving the skull at the foramen jugulare, the nerve descends in front of the cervical vertebræ, lying successively upon the rectus capitis anticus major and the longus colli. In the upper part of the neck it is situated, lying in the same sheath, between the internal carotid artery and the internal jugular vein ; lower down it lies between and behind the common carotid and the internal jugular vein. It enters the chest on the right side, crossing in front of the first part of the subclavian artery, nearly at a right angle ; on the left, running nearly parallel with it.

In their course through the chest the pneumogastric nerves have not similar relations. The *right* nerve lies beneath the subclavian vein, and then descending behind the right brachio-cephalic vein by the side of the trachea, is continued behind the right bronchus to the posterior part of the œsophagus. The *left* nerve passes behind the left brachio-cephalic vein, then crosses in front of the arch of the aorta, and behind the left bronchus to the anterior part of the œsophagus. Both nerves subdivide on the œsophagus into a plexus, the right nerve forming the *posterior œsophageal plexus*, the left the *anterior*. Each plexus again collects its fibres together to form a single trunk ; thus two main nerves are formed which pass with the œsophagus through the diaphragm ; of these the right is distributed over the posterior, the left over the anterior surface of the stomach.*

In their long course from the medulla to the abdomen the pneumogastric nerves supply branches to most important organs ; namely, to the pharynx, the larynx, the heart, the lungs, the œsophagus, the stomach, and the liver.

The branches of the pneumogastric are those of communication and those of distribution : —

1. The *branches of communication* are those in connection with the ganglion of the root and the ganglion of the trunk.

a. The *ganglion of the root* has connecting filaments with the accessory portion of the spinal accessory, the superior cervical ganglion of the sympathetic, and with the petrous ganglion of the glosso-pharyngeal.

b. The *ganglion of the trunk* has communicating filaments with the hypoglossal, the loop between the first two cervical nerves, and the superior cervical ganglion of the sympathetic.

2. The *branches of distribution* are —

a. The *auricular* (Arnold), which cannot at present be seen, will be made out in the dissection of the nerve at the base of the skull.

b. The *pharyngeal* arises from the upper part of the ganglion of the trunk, and, receiving a filament from the accessory part of the spinal accessory, descends

* The difference in the course and destination of the right and the left pneumogastric nerves may be explained in the process of development. The student is therefore referred to works which treat of this subject.

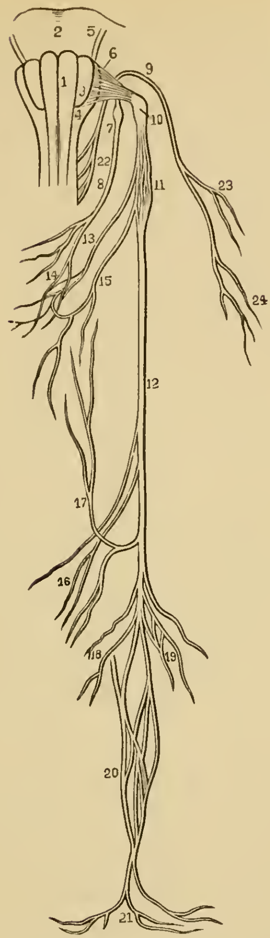


FIG. 59.—APPARENT ORIGIN AND DISTRIBUTION OF THE GLOSSO-PHARYNGEAL, PNEUMOGASTRIC, AND SPINAL ACCESSORY NERVES.

1, 3, 4. Medulla. 1. Ant. pyramid. 3. Olivary body. 4. Restiform body. 2. Pons. 5. Seventh or facial. 6. Origin of the glosso-pharyngeal. 7. Ganglion of Andersch. 8. Trunk of the nerve. 9. Spinal accessory nerve. 10. Superior or ganglion of the root of the pneumogastric nerve. 11. Inferior or ganglion of the trunk. 12. Trunk. 13. Pharyngeal branch forming pharyngeal plexus (14), assisted by a branch from the glosso-pharyngeal (8), and one from the superior laryngeal nerve (15). 16. Cardiac branches. 17. Recurrent laryngeal branch. 18. Anterior pulmonary and cardiac branches. 19. Posterior pulmonary and cardiac branches. 20. Œsophageal plexus. 21. Gastric branches. 22. Origin of the spinal portion of the spinal accessory nerve. 23. Branches of the whole nerve to sterno-mastoid muscle. 24. Branches to the trapezius.

either in front of or behind the internal carotid. The nerve, after passing to the inner side of the internal carotid, divides into branches, which with the other filaments (described p. 157) upon the middle constrictor muscle form the *pharyngeal plexus*. From this plexus branches are distributed to the muscles and the mucous membrane of the pharynx.*

c. The *superior laryngeal*, derived from the middle of the ganglion of the trunk, descends behind the internal carotid, and divides into two branches, the internal and the external laryngeal.

The *internal laryngeal* passes to the interval between the os hyoides and the thyroid cartilage, and enters the larynx (with the superior laryngeal a.), through the thyro-hyoid membrane, to be distributed, as a nerve of sensation, to the mucous membrane of the larynx and epiglottis. The *external laryngeal*, the smaller, gives off some branches to the pharyngeal plexus, the inferior constrictor, and the thyroid body, and then descends by the side of the larynx beneath the depressors of the os hyoides to supply the crico-thyroid muscle; it communicates with the superior cardiac nerve of the sympathetic.

d. The *cervical cardiac branches* descend behind the sheath of the carotid artery to the cardiac plexus. The *upper branches*, one or two in number, are small, and proceed from the ganglion of the trunk; they join the cardiac branches of the sympathetic and the deep cardiac plexus; the *lower* comes from the trunk of the pneumogastric before it enters the chest. Subsequently, the right lower cardiac nerve descends by the side of the innominate artery to join the deep cardiac plexus; the left passes over the arch of the aorta to join the superficial cardiac plexus.

e. The *inferior* or *recurrent laryngeal nerve* turns, *on the right side*, under the subclavian artery (p. 129), and ascends obliquely inwards to the larynx behind the common carotid and the inferior thyroid arteries; it lies subsequently in the groove between the œsophagus and the trachea. *On the left side*, it turns under the arch of the aorta, just on the outer side ot the remains of the ductus arteriosus; after which it runs up between the trachea and the œsophagus. On both sides the nerves enter the larnyx beneath the lower border of the inferior constrictor, and supply all the intrinsic muscles of the larynx except the crico-thyroid. These nerves, as they turn under their respective vessels, give off cardiac branches to the deep cardiac plexus. They supply also filaments to the trachea, œsophagus, and inferior constrictor muscle.

The remaining branches of the pneumogastric nerve to the lungs, heart, œsophagus, and stomach will be examined in the dissection of the chest.

Spinal Accessory Nerve, or Eleventh N. — The *spinal accessory nerve* issues through the middle part of the foramen jugulare, in a sheath of dura common to it and the pneumogastric nerve. It is a motor nerve, for the most part deriving its small sensory and also some motor element from its vagal or accessory or *Obertseiner* filaments in the medulla. (A. H.) It arises by numerous filaments from the side of the medulla below the pneumogastric, and from the lateral column of the spinal cord as low down as the sixth cervical vetebra. The

* A branch from the plexus is described by Luschka as receiving filaments from the pharyngeal branches of the glosso-pharyngeal and pneumogastric nerves, and joining with the hypoglossal as it winds round the occipital artery.

filaments which arise from the medulla join to form the *accessory portion* of the nerve; the spinal filaments ascend between the ligamentum denticulatum and the posterior roots of the cervical spinal nerves, and form the *spinal portion* of the nerve. These portions converge to the jugular foramen, where they communicate with each other more or less, and are then continued onwards below the jugular foramen as two portions — the internal or accessory, which joins the pneumogastric n.; the external or spinal, which is distributed to muscles.

The *accessory part*, within the foramen jugulare, sends one or more filaments to the ganglion of the root of the pneumogastric. It lies close to the pneumogastric nerve at the ganglion of the trunk, and is finally incorporated with the nerve below the ganglion. It sends filaments to the pharyngeal and superior laryngeal branches of the pneumogastric.

The *spinal part* separates from the accessory part below the foramen jugulare. It then takes a curved course backwards and outwards, lying in front of the internal jugular vein and the transverse process of the atlas, and behind the digastric and stylo-hyoid muscles. It pierces the upper part of the sterno-mastoid muscle accompanied by the superior sterno-mastoid artery, a branch of the occipital, and supplies the muscle, joining in its substance with branches from the third cervical n. The nerve then crosses obliquely the occipital triangle, where it communicates with the second and third cervical nerves. It is eventually distributed to the under aspect of the trapezius, where it is joined by branches from the third and fourth cervical nerves.

Hypoglossal Nerve. — The *apparent origin* of this nerve is by from ten to fifteen filaments, from the groove between the anterior pyramid and the olivary body. It passes through the dura in two fasciculi, which emerge from the skull through the anterior condylar foramen, and then unite to form a single nerve. It comes forward between the internal jugular vein and the internal carotid artery, where it is intimately connected with the pneumogastric nerve. Its further course has been described (p. 118).

In the anterior condylar foramen the hypoglossal gives off a small filament to the diploë and to the dura around the foramen magnum. At the base of the skull it gives off several branches, which connect it with the ganglion of the trunk of the pneumogastric-nerve. These two nerves are sometimes almost inseparably united. It gives off also several delicate filaments to the

superior cervical ganglion of the sympathetic, and communicates with the loop formed by the first two spinal nerves in front of the atlas.

Sympathetic Nerve. — Now examine the cervical ganglia of the sympathetic system of nerves. This system consists of a series of ganglia arranged on each side of the spine, from the first cervical to the last sacral vertebra. The successive ganglia of the same side are connected by intermediate nerves, so as to form a continuous cord on each side of the spine; this constitutes what is called the trunk of the sympathetic system, and is connected with all the spinal nerves. Its upper or cephalic extremity enters the cranium through the carotid canal, surrounds the internal carotid artery, communicates with the third, fourth, fifth, and sixth cranial nerves, and joins its fellow of the opposite side upon the anterior communicating artery.* Its sacral extremity joins its fellow by means of the little *ganglion impar*, situated in the mesial line, upon the cocyx.

The ganglia are connected together by branches composed of gray and white nerve fibres; they are also connected with the spinal nerves by two filaments — one, of white nerve-fibres, which passes from the spinal nerve to the ganglion; the other, of gray, from the ganglion to the spinal nerve. Branches of distribution are also given off by the ganglia, some to the various blood-vessels and viscera, forming intricate plexuses upon them; others to the various ganglia of the viscera — the cardiac and semilunar ganglia.

The different portions of the sympathetic gangliated cord receive, respectively, the distinguishing names of the cervical, thoracic, lumbar, sacral, and coccygeal. At present we have only to consider the cervical portion of it.

To expose the cervical ganglion of the sympathetic, the internal carotid artery, the pneumogastric, glosso-pharyngeal, and hypoglossal nerves should be cut through, near the base of the skull; then by careful dissection the superior cervical ganglion can be traced out.

Cervical Ganglia of Sympathetic. — In the cervical portion of the sympathetic are three ganglia, named from their position, superior, middle, and inferior.

The *superior cervical ganglion*, the largest of the three, is situated near the base of the skull, opposite the second and third

* Here is situated the so-called *ganglion of Ribes*.

cervical vertebræ, upon the rectus capitis anticus major, and lies behind and on the inner side of the internal carotid artery. It is of a reddish-gray color like the other ganglia, of an elongated oval shape, varying in length from one to two inches (*2.5 to 5 c.m.*).

To facilitate the description of its several branches, we divide them into an upper, a lower, an external, an internal, and an anterior set —

a. Its *upper* or *cranial* branch runs with the internal carotid a. into the carotid canal of the temporal bone, and there divides into two branches, an outer and an inner. The *outer* and larger branch accompanies the artery through its bony canal, ramifies upon it by the side of the body of the sphenoid, and so constitutes the "CAROTID PLEXUS." * From this outer branch a filament proceeds to the Gasserian ganglion; another to the sixth cranial nerve; a third joins the great petrosal branch of the facial, and forms the Vidian nerve, and thus communicates with the spheno-palatine ganglion. It also communicates in the carotid canal with the tympanic branch of the glosso-pharyngeal. The *inner* branch, running on with the artery to the cavernous sinus, there forms another plexus, called from its position the "CAVERNOUS PLEXUS." Here the sympathetic is seen to communicate with the third, the fourth, and the ophthalmic branch of the fifth and sixth cranial nerves, and with the ophthalmic ganglion. Lastly, from both these plexuses secondary plexuses proceed, of which the minute filaments ramify on, and supply the coats of, the terminal branches of the internal carotid.

b. The *lower branch* descends and joins the middle cervical ganglion of the sympathetic.

c. The *external branches* are numerous, and connect the ganglion with the ganglion of the pneumogastric and hypoglossal nerves, and with the four upper cervical spinal nerves. A small twig also joins the petrossal ganglion of the glosso-pharyngeal and the upper ganglion of the pneumogastric in the foramen jugulare.

d. The *internal branches* are distributed to the pharynx, larynx, and the heart. The pharyngeal branches join the pharyngeal plexus on the middle constrictor of the pharynx; the laryngeal join the superior laryngeal nerve; the cardiac nerves, one or more in number — *superior cardiac* — descend behind the sheath of the carotid in front of the inferior thyroid artery and recurrent laryngeal nerve, and, entering the chest, join the superficial and deep cardiac plexuses.

e. The *anterior branches* lie in front of the external carotid artery and ramify around this vessel and its branches, forming the various plexuses, and named, on account of their delicacy, the *nervi molles.* In some of these plexuses are occasionally seen several ganglia, the *intercarotic*,† lingual, temporal, and pharyngeal ganglia. They are connected with the several ganglia about the head and neck; namely, the ophthalmic, spheno-palatine, otic, and submaxillary or submandibular.

The *middle cervical ganglion*, the smallest of the three ganglia, is something less than a barleycorn in size. It is situated behind the carotid sheath, about the fifth or sixth cervical vertebra on or near the inferior thyroid artery.

* A small ganglion, the *carotid ganglion*, is sometimes met with in this plexus on the under aspect of the artery.

† Situated in the angle at the bifurcation of the common carotid into the external and internal carotid arteries; it corresponds in structure with the coccygeal gland.

a. It is connected by branches with the superior ganglion above, and with the inferior cervical ganglion below.

b. Its *external branches* usually pass outwards to join the fifth and sixth cervical spinal nerves.

c. Its *internal branches* are distributed to the thyroid body and the heart. The *branches to the thyroid body* accompany the inferior thyroid artery, and join the superior cardiac nerve, and in the gland they communicate with the external

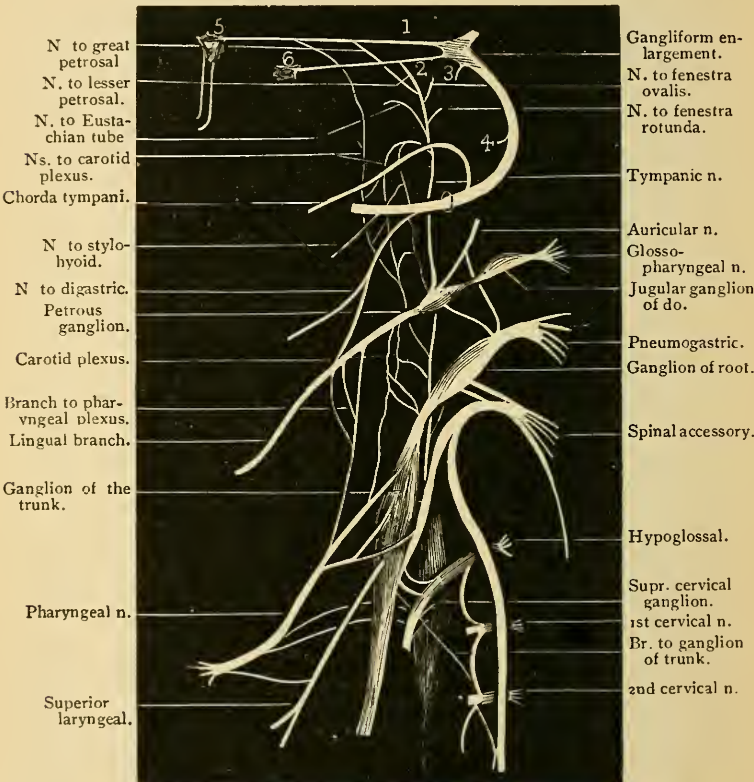


FIG 60.—DIAGRAM OF THE COMMUNICATIONS OF THE FACIAL GLOSSO-PHARYNGEAL, PNEUMOGASTRIC, SPINAL, ACCESSORY, HYPOGLOSSAL, SYMPATHETIC AND THE TWO UPPER CERVICAL NERVES.

1. Great petrosal nerve. 2. Lesser petrosal nerve. 3. External petrosal nerve. 4. Nerve to Stapedius muscle. 5. Spheno-palatine ganglion. 6. Otic ganglion.

and recurrent laryngeal nerves. The *middle cardiac nerve*, the largest of the three cardiac nerves, descends, on the right side behind the common carotid a., usually in front of the first part of the subclavian artery, into the chest, when it lies on the trachea. It is joined by some cardiac filaments from the recurrent larnygeal nerve and superior cardiac nerve, and joins the deep cardiac plexus. On the left side this cardiac nerve enters the chest between the left carotid and subclavian arteries.

In cases where the middle cervical ganglion is absent, the preceding nerves are supplied by the sympathetic cord connecting the superior and inferior ganglia.

The *inferior cervical ganglion* is of considerable size, and is situated in the interval between the base of the transverse process of the seventh cervical vertebra and the neck of the first rib, immediately behind the vertebral artery, and to the inner side of the superior intercostal artery. Not infrequently it is coalesced with the first thoracic sympathetic ganglion.

Its branches are as follows : —

a. Superior branches which pass upwards and connect it with the middle cervical ganglion.

b. Inferior branches which descend, some in front of, and some behind, the subclavian a., to join the first thoracic ganglion. One of these, the *inferior cardiac nerve*, passes behind the subclavian a in front of the trachea, to join the deep cardiac plexus, beneath the arch of the aorta, and communicates with the recurrent laryngeal and middle cardiac nerves.

c. External branches which communicate with the seventh and eighth cervical nerves; others form a plexus around the vertebral artery, which join with the fourth, fifth, and sixth cervical nerves.

DISSECTION OF THE THORAX.

Before the several organs contained in the thorax are examined, the student should have some knowledge of its framework. The ribs with their cartilages describe a series of arcs increasing in length from above downwards, and form, with the thoracic vertebræ behind and the sternum in front, a barrel of a conical shape, broader in the lateral than in the antero-posterior diameter. The spaces between the ribs are occupied by the intercostal muscles. In each intercostal space there are two layers of these muscles, arranged like the letter X. The fibres of the outer layer run obliquely from above downwards and forwards ; those of the inner layer in the reverse direction. The base is closed in the recent state by a muscle — the diaphragm — which forms a muscular partition between the chest and the abdomen. This partition is arched upwards, so that it constitutes a vaulted floor for the chest, and by its capability of alternately falling and rising, it increases and diminishes the capacity of the thorax.

In front, the diaphragm is attached to the ensiform cartilage, but it slopes posteriorly, to become attached to the last rib. The circumference of the diaphragm is convex and muscular ; in the centre it is flattened and aponeurotic. On the right side it cor-

responds, in front, with the upper border of the cartilage of the fifth rib; on the left side it corresponds with the upper border of the sixth rib.

The upper opening of the osseous thorax is bounded posteriorly by the body of the first thoraic vertebra, laterally by the first ribs, and in front by the upper border of the manubrium sterni.*

Such, in outline, is the framework of the thorax, which contains the heart with its large vessels and the lungs. Its walls are composed of different structures — bone, cartilage, muscles, and ligaments, which fulfil two important conditions: 1st, by their solidity and elasticity they proteet the important organs contained in the thorax; 2ndly, by their alternate expansion and contraction they act as mechanical powers of respiration. For they can increase the capacity of the chest in three directions: in height, by the descent of the diaphragm; in width, by the rotation of the ribs; and in depth, by the elevation of the sternum.

The chest of the female differs from that of the male in the following points: Its general capacity is less; the sternum is shorter; the upper opening is larger in proportion to the lower; the upper ribs are more movable, and therefore permit a greater enlargement of the chest at its upper part, in adaptation to the condition of the abdomen during pregnancy.

The *upper opening of the thorax* gives passage to the trachea, the œsophagus, the large vessels of the head and neck and upper extremities, viz., the innominate, the left carotid, and subclavian arteries, with the left innominate and right subclavian and internal jugular veins, the superior intercostal and internal mammary arteries, the inferior thyroid veins, the sterno-hyoid, sterno-thyroid, and longus colli muscles of each side, the pneumogastric, the left recurrent laryngeal, the phrenic, and the sympathetic

* That the student may have some knowledge of the diameters of the chest at different situations, the following measurements have been taken from a well-articulated male skeleton of the average height: The *antero-posterior* diameter at the upper opening of the thorax is 2¼ inches (*5.6 cm.*), at the articulation of the manubrium with the gladiolus it is 4½ inches (*11.2 cm.*), and at the junction of the gladiolus with the ensiform cartilage it has increased to 5⅝ (*14.25 cm.*) inches. The *transverse diameter* of the upper opening was found to be 4⅜ inches (*11 cm.*); between the second ribs, 7 inches (*17.5 cm.*); between the third, 8⅛ inches (*20.3 cm.*); the diameter increased in regular proportion as far as the ninth rib, where it attained a measurement of 10⅝ inches (*26.6 cm.*); below this it gradually decreased. The upper border of the manubrium corresponds to the second thoracic vertebra. The articulation of the manubrium and the gladiolus is on a level with the fourth thoracic vertebra; and, lastly, the junction of the ensiform cartilage with the gladiolus is on a level with the border of the ninth or tenth thoracic vertebra.

nerves ; the cardiac branches of the sympathetic, and the cardiac branches of the pneumogastric ; also to the anterior branch of the first thoracic nerve as it passes up to join the brachial plexus, the thoracic duct, the thymus gland (in early life), and, lastly, to the apices of the lungs, which, with their pleural covering, rise up on each side into the neck for about one inch and a half (*3.75 cm.*) above the clavicle ; the interspaces between these various structures being occupied by a dense fibro-cellular tissue, continuous with the deep cervical fascia.

The diaphragm, which forms the base of the thorax, is pierced by the following foramina : The *aortic opening*, for the passage of the aorta, vena azygos major, thoracic duct ; the *œsophageal opening* for the œsophagus, pneumogastric nerves, and œsophageal branch of the coronaria ventriculi artery ; the *foramen quadratum*, for the vena cava inferior, a branch of the right phrenic nerve and lymphatics from the liver ; the *right crus* transmits the greater and lesser splanchnic nerves ; the *left crus*, in addition, transmits the vena azygos minor. In front there are the narrow intervals for the passage of the internal mammary arteries.

Dissection.* — An opening must be made into the chest by carefully removing the upper four-fifths of the sternum, and the cartilages of all the true ribs.† In doing this, care must be taken not to wound the pleura, which is closely connected with the cartilages. On one side the internal mammary artery should be dissected ; on the other removed.

In the erect position the apex of the heart pulsates between the fifth and sixth ribs, two inches below the left nipple and one inch to its sternal side. In deep respiration it may descend half an inch.

The relation of the chief cardiac orifices, one to the other and to the chest wall, is as follows : —

1. The pulmonary semilunar valves are anterior in position to the aortic, and are placed behind the junction of the third costal cartilage with the sternum on the left side.

* The student is advised in making the dissection of the thorax to introduce large hat-pins (similar to those used by ladies in fastening the hat to the hair of their heads) to outline the position of the heart before removing the anterior chest wall. — A. H

† Those who are more proficient in dissection should not remove the whole of the sternum, but leave a quarter of an inch of its upper part with the first rib attached to it. This portion serves as a valuable landmark, although it obstructs, to a certain extent, the view of the subjacent vessels.

2. The aortic semilunar valves are more deeply placed than the pulmonary semilunar valves, and lie behind the third intercostal space close to the left side of the sternum.

3. The tricuspid valves lie behind the sternum, and on the middle line and between the junction of the fourth costal cartilages with the sternum.

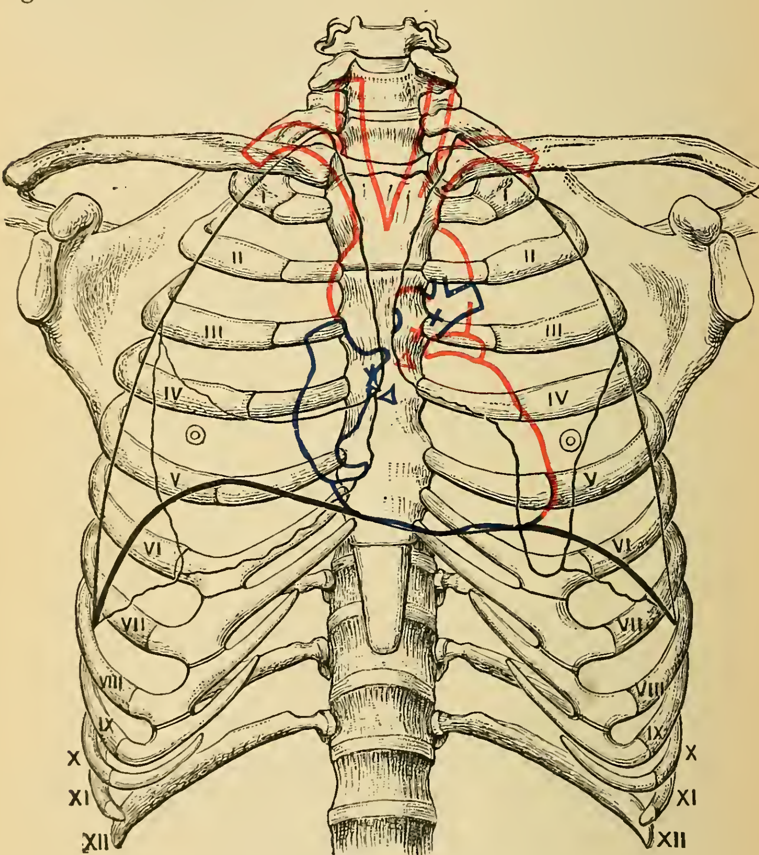


FIG. 61.—SHOWING THE POSITION OF THE HEART AND ITS VALVES IN RELATION TO THE CHEST WALLS. (AFTER MORRIS.)

4. The mitral valves (deepest of all) lie behind the third intercostal space, about an inch to the left of the sternum.

These valves are so situated that the mouth of an ordinary-sized stethoscope will cover a portion of them all, if placed over the sternal end of the third intercostal space on the left side.

In order to auscult them separately, it is found that the aortic valve sound is best heard over the second intercostal space at the right border of the sternum. The pulmonary valve sound is over the second intercostal space at the left border of the sternum. The tricuspid valve sound is over the middle of the sternum above the ensiform cartilage. The mitral valve sound is best heard over the apex of the heart. A circle two inches in diameter made around a point midway between the left nipple and the end of the sternum will define sufficiently for all practical purposes that part of the heart which lies immediately behind the wall of the chest and is not covered by lung or pleura.

In the dissection of the chest let us take the parts in the following order: —

1. Triangularis sterni, with the internal mammary artery.
2. Mediastina, anterior, middle, posterior, and superior.
3. Pleura.
4. Position and form of the lungs.
5. Pericardium.
6. Position and relations of the heart.
7. Posterior mediastinum and its contents; namely, the aorta, the thoracic duct, the vena azygos, the œsophagus, and pneumogastric nerves.
8. Right and left brachio-cephalic veins and superior vena cava.
9. Course of the phrenic nerves.
10. Course and relations of the arch of the aorta.
11. The three great branches of the arch.
12. Sympathetic nerve.
13. Intercostal muscles, vessels, and nerves.
14. Nerves of the heart; cardiac plexuses.

Triangularis Sterni. — On the under surface of the sternum and cartilages of the ribs is a thin, flat muscle, named the *triangularis sterni.* It *arises* from the ensiform cartilage, the lower part of the side of the sternum, and the cartilages of two or three lower true ribs. Its fibres ascend obliquely outwards, and are *inserted* by fleshy digitations into the lower borders of the cartilages of the true ribs — from the sixth to the second. Its lowest digitation runs transversely outwards; each successive one, however, becomes more oblique, so that the highest one is nearly vertical in direction. The muscle is evidently a continuation upwards of the anterior portion of the transversalis abdominis. Its *action* is to draw down the costal cartilages, and thus it acts in expiration. Its *nerves* come from the intercostal nerves, its *arteries* from the internal mammary.

Internal Mammary Artery. — This artery is given off from the subclavian in the first part of its course opposite the thyroid axis. It passes down behind the clavicle, and on entering the

chest it lies between the cartilage of the first rib and the pleura, and is crossed by the phrenic nerve. It then descends perpendicularly, about half an inch (*12.5 mm.*) from the sternum, lying on the pleura and behind the costal cartilages; lower down it gets between the cartilages of the ribs and the triangularis sterni, as far as the seventh costal cartilage, where it divides into two branches, the *musculo-phrenic* and the *superior epigastric.** The latter branch then enters the wall of the abdomen behind the rectus abdominis, and finally inosculates with the deep epigastric (a branch of the external iliac). The branches of the internal mammary are as follows: —

a. Arteria comes nervi phrenici. — A very slender artery, which accompanies the phrenic nerve between the pleura and pericardium to the diaphragm, and anastomoses with the phrenic branches of the abdominal aorta and internal mammary.

b. Mediastinal, pericardic, sternal, and thymic. — These branches supply the cellular tissue of the anterior mediastinum, the pericardium, and the triangularis sterni. The *thymic* are only visible in childhood, and disappear with the thymus gland.

c. Anterior intercostal. — Two for each intercostal space are distributed to the five or six upper intercostal spaces. They pass outwards, and lie at first between the pleura and the internal intercostal muscle, and subsequently between the two intercostals. They inosculate with the intercostal arteries from the aorta.

d. The *perforating arteries* pass through the same number of intercostal spaces as the preceding branches, and supply the pectoral muscle and skin of the chest. In the female they are of large size (especially the third), to supply the mammary gland.

e. The *musculo phrenic* branch runs outwards behind the cartilages of the false ribs, pierces the attachment of the diaphgram, and terminates near the last intercostal space. It supplies small branches to the diaphragm, to the sixth, seventh, and sometimes the eighth intercostal spaces.

Two venæ comites accompany the artery, and form a single trunk at the upper part of the chest, which terminates in the brachio-cephalic vein of its own side.

Lymphatic Glands. — There are several *lymphatic glands* in the neighborhood of the internal mammary artery. They receive the lymphatics from the upper part of the abdominal wall, the diaphragm, the inner portion of the mammary gland, and the intercostal spaces. On the right side they terminate in the right lymphatic duct, on the left in the thoracic duct. In disease of the inner portion of the mamma these glands may enlarge without any enlargement of those in the axilla.

* The widest intercostal space is the third. Then the second, and finally the first. This may be of value in wounds of the chest, when the internal mammary has to be ligated. Care should be taken not to open the pleural cavity. — A. H.

Pleura. — As the lungs are constantly gliding to and fro within the chest they are provided with a serous membrane to facilitate their motion. This membrane is termed the *pleura*. There is one for each lung. Each pleura forms a completely closed sac, and, like all other serous sacs, has a *parietal* and a *visceral layer* — that is, the first layer lines the containing walls, the latter is reflected over the contained organ or viscus. Its several parts are named after the surface to which they adhere; the parietal layer, which lines the ribs and intercostal muscles, is called *pleura costalis;* the visceral layer, which invests the lungs, *pleura pulmonis;* between these two layers is a space which is termed *the cavity of the pleura.*

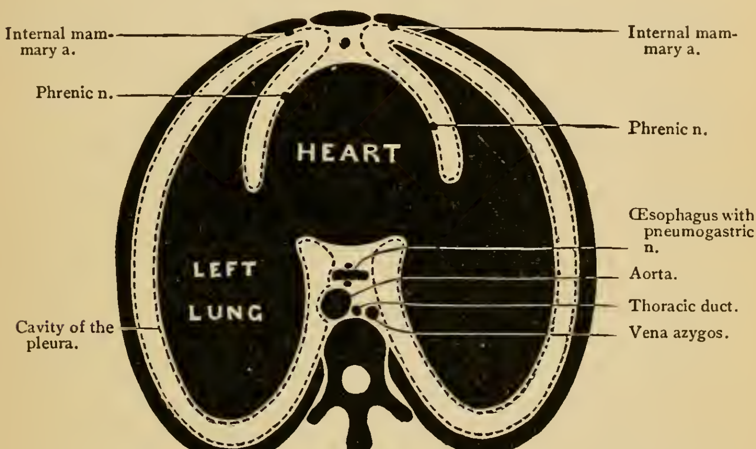


FIG. 62. — DIAGRAM OF THE REFLECTIONS OF THE PLEURAL SACS IN DOTTED LINES.

Each pleura occupies its own half of the thorax; they do not communicate with one another, nor do they come into contact with each other, except for the short distance of about two inches (*5 cm.*) in front, behind the sternum.

Unlike the peritoneum, the pleura forms no folds except a small one, called *ligamentium latum pulmonis*, which extends from the root of the lung to the diaphragm.

The *pleura costalis* (Fig. 62), in front, lines part of the back of the sternum and the inner surfaces of the costal cartilages; laterally, it is reflected over the ribs and the intercostal muscles; posteriorly, it is traced over the sides of the bodies of the thoracic vertebræ; thence it passes to the back of the pericardium,

over the posterior aspect of the root of the lung. It may now be traced, as the *pleura pulmonalis*, over the surface of the lung, to which it is intimately adherent, into the fissures between the lobes, as far as the anterior border of the lung; thence round its pericardial aspect to the front of the root of the lung, passing forwards over the pericardium to the back of the sternum. Its only reflection, the ligamentum latum pulmonis, has been already alluded to. Below, the pleura covers the diaphragm.

The pleura rises as a conical dome into the base of the neck, about an inch (*2.5 cm.*) above the clavicle, and is strengthened in this situation by expansions from the scaleni muscles.*

The thickness of the pleura differs: on the lung it is thin, semi-transparent, and firmly adherent; on the ribs and diaphragm it is thick, and may be easily separated from its osseous and muscular connections.†

The spaces called *anterior* and *posterior mediastina*, formed by the separation of the pleuræ, will be described further on.

In health the internal surface of the pleura is smooth, polished, and lubricated by moisture sufficient to facilitate the sliding of the lung. When this surface is thickened and roughened by inflammation, the moving lung produces a friction sound. When the pleural sac is distended by serum, it constitutes hydrothorax; when by pus, empyema; when by air, pneumo-thorax; when by blood, hæmo-thorax.

Introduce your hand into the pleural sac, and ascertain that the reflection of the pleural on to the diaphgram corresponds with an imaginary line commencing at the lower part of the sternum and sloping along the cartilages of the successive ribs down to the lower border of the last rib. Supposing a ball to lodge in the pleural sac, it might fall upon the dome of the diaphragm, and roll down to the lowest part of the pleural cavity. The place, therefore, to extract it, would be in the back, at the eleventh intercostal space. The operation has been done during life with success.

If a transverse section were made through the chest (*see* Fig.

* A slip is described by Sibson as passing from the transverse process of the last cervical vertebra, and, spreading out, is inserted into the pleural dome and the inner margin of the first rib.

† From the prevertebral fascia, a ligamentous band passes downwards along the inner border of the lung to be attached to the pericardium and the central tendon of the diaphragm. As it passes downwards it embraces the root of the lung, and supports it in its proper position. This band has been described as the "suspensory ligament of the diaphragm," by Teutleben.

62), you would observe that as the pleuræ nowhere come into actual contact, a space is left between them extending from the sternum to the spine, and which is larger in the middle than in front or behind. This interval is called by anatomists the *interpleural space* or the mediastinum, and for convenience' sake is subdivided into three parts — an *anterior*, *middle*, and *posterior mediastinum*.

Mediastina, Anterior, Middle, and Posterior. — The *mediastina* are the space which the two pleural sacs leave between them in the antero-posterior plane of the chest, and which contain all the thoracic viscera except the lungs. There is an anterior, a middle, and a posterior mediastinum. To put these spaces in the simplest light, let us imagine the heart and lungs to be removed from the chest, and the two pleural sacs to be left in it by themselves. The two sacs, if inflated, would then appear like two bladders, in contact only in the middle, as shown by the dotted outlines in the annexed scheme (Fig. 63). The interval marked *a*, behind the sternum, would represent the *anterior mediastinum*; the interval *b*, the *posterior mediastinum*. Now let us introduce the heart again, between the two pleural sacs: these must give way to make room for it, so that the two sacs are largely separated in the middle line of the chest; and the space thus occupied by the heart and large vessels takes the name of the *middle mediastinum*.

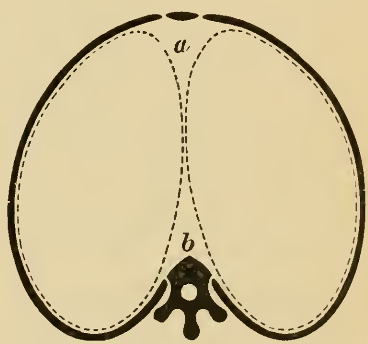


FIG. 63.

Looking at the chest in front, the *anterior mediastinum* appears as shown in the diagram (Fig. 64). It is not precisely vertical in its direction, for it inclines slightly towards the left, owing to the position of the heart. Its area varies; thus it is very shallow from before backwards; it is extremely narrow in the middle where the edges of the lungs nearly meet; it is wider above, and widest of all below, where the lungs diverge. Posteriorly it is limited by the pericardium covering the heart, aorta, and its branches, and the pulmonary artery.

What parts are contained in the anterior mediastinum? The remains of the thymus gland, the origins of the sterno-hyoid,

sterno-thyroid, and triangularis sterni muscles, the left bracio-cephalic vein (which crosses behind the first bone of the sternum), a few lymphatic glands, and the left internal mammary artery and vein.

The *posterior mediastinum* (Fig. 62) is triangular in shape, placed in front of the thoracic vertebræ ; it contains the œsophagus, the two pneumogastric nerves, the descending aorta, the thoracic duct, the greater and smaller azygos veins, the left superior intercostal vein, and some lymphatic glands. This space will be described in detail at a later stage.

The *middle mediastinum* is the largest of the mediastina, and contains the heart enclosed in the pericardium, the vena cava superior, the ascending aorta, the pulmonary arteries and veins, the phrenic nerves with their accompanying arteries, and the bifurcation of the trachea.

A *superior mediastinum* has also been described, comprising that part of the interpleural space which lies above a horizontal plane, extending behind from the lower part of the body of the fourth thoracic vertebra to the articulation between the manubrium and gladiolus in front. The contents of this mediastinum include all those structures found above this nearly horizontal plane, and are the transverse portion of the arch of the aorta and its three large branches, the trachea, œsophagus, and thoracic duct, the innominate veins, superior vena cava, left recurrent laryngeal nerve, phrenic, pneumogastric, and cardiac nerves, lymphatic glands, and the thymus or its remains.

Before passing to the dissection of the contents of the thorax, the student should carefully trace the outline of the free borders of the pleuræ as seen in the front of the chest. As the margins of the lungs for all practical purposes correspond with the borders of the pleuræ, we shall confine our description to the more important of the two structures, viz., the lungs. The value of this investigation is, that we are enabled to trace upon a living chest the outlines of the lungs, and know what parts are naturally resonant on percussion.

Commencing from above (Fig. 64), we find that the apex of the lung extends into the neck, from an inch to an inch and a half (*2.5 to 3.75 cm.*) above the clavicle. This part of the lung ascends behind the subclavian artery and the scalenus anticus muscle, and deserves especial attention, because it is, more than any other, the seat of tubercular disease. From the sternal end of the clavicles the lungs converge towards the middle line,

where their borders nearly meet opposite the junction of the second rib. · There is thus little or no lung behind the manubrium sterni.

From the level of the second costal cartilage to the level of the fourth, the inner margins of each lung run nearly parallel and almost in contact behind the middle of the sternum ; consequently they overlap the great vessels at the root of the heart.

Below the level of the fourth costal cartilage the margins of

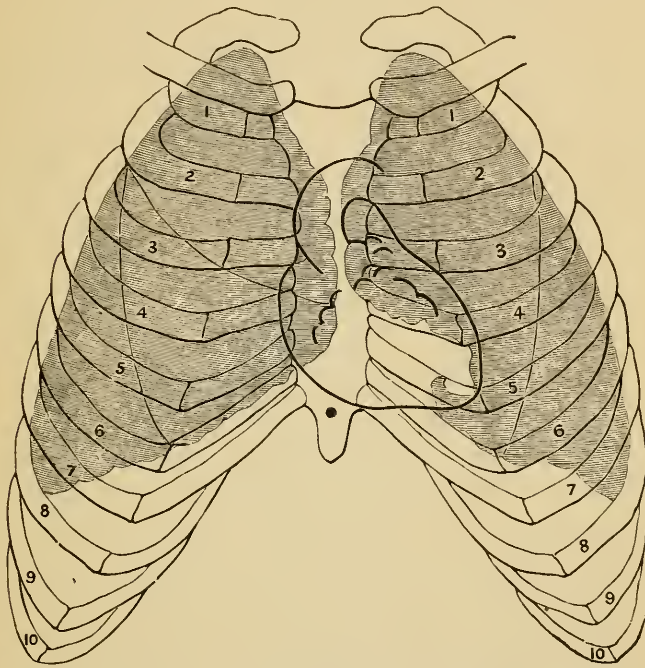


FIG. 64. — FORM OF THE LUNGS ; AND THE EXTENT TO WHICH THEY OVERLAP THE HEART AND ITS VALVES.

the lungs diverge from each other, but not in an equal degree. The *left* presents the notch for the heart, and follows nearly the course of the fourth costal cartilage ; at the lower part of its curve it projects more or less over the apex of the heart like a little tongue. The *right* descends almost perpendicularly behind the sternum as low as the attachment of the ensiform cartilage, and then turning outwards corresponds with the direction of the sixth costal cartilage. Hypertrophy of the heart, or effusion

into the pericardium, will not only raise the point where the lungs diverge above the ordinary level, but also increase their divergence; hence the greater dulness on percussion.*

Position and Form of the Lungs. — The two lungs are situated in the chest: each in its own half of the thorax, with the heart, enclosed in its pericardium, between them. Each fits accurately into the cavity which contains it. Each, therefore, is conical in form; the *apex* projects into the root of the neck, a little more than an inch (*2.5 cm.*) above the sternal end of the clavical; the *base* is broad and rests on the diaphragm, the posterior part being thin and extending as far as the eleventh rib. Its *outer surface* is convex and adapted to the ribs; its *inner surface* is excavated, to make room for the heart in front; and behind presents a deep fissure — *hilum pulmonis* — for the attachment of the root of the lung. Its *posterior* surface is convex, and fits into the concavity of the thorax, on each side of the spinal column. The best way to see the shape of the lungs is to inject them through the trachea with wax, which is tantamount to taking a cast of each thoracic cavity. In such a preparation, besides the general convexities and concavities alluded to, you would find in the right lung a little indentation for the right brachio-cephalic vein; in the left an indentation for the arch of the aorta and the left subclavian artery.

Each lung is divided into an *upper* and a *lower lobe* by a deep fissure, which commences, behind, about three inches (*7.5 cm.*) from the apex, and proceeds obliquely downwards and forwards to the junction of the sixth rib with its cartilage (Fig. 64). Speaking broadly, nearly the whole of the anterior portion of the lung is formed by the upper lobe; nearly the whole of the posterior portion by the lower lobe. It should be noticed, however, that the upper lobe of the right lung is divided by a second fissure which marks off, from its lower part, a triangular portion called its *middle lobe*.

Relations of the Lungs to the Chest-Wall. — The margins of the lungs may be outlined on the chest-wall by drawing a line through the sterno-clavicular joint to the middle of the sternum, at the junction of the manibrum and gladiolus. These margins continue in contact behind the middle of the sternum, covered by the pleura to the level of the junction of the fourth costal

* Effusion into the left pleura sac will cause the tympanic note over the lunated portion of the stomach not covered by the liver to give a dull or flat note on percussion. Traube semilunar area. — A. H.

cartilage with the sternum. The margin of the *right* lung diverges slightly here to the junction of the sixth cartilage with the sternum; from this point the basal margin describes a curve which, in the nipple line, touches the sixth costo-chondral articulation, in the mid-axillary line the eighth or ninth rib according

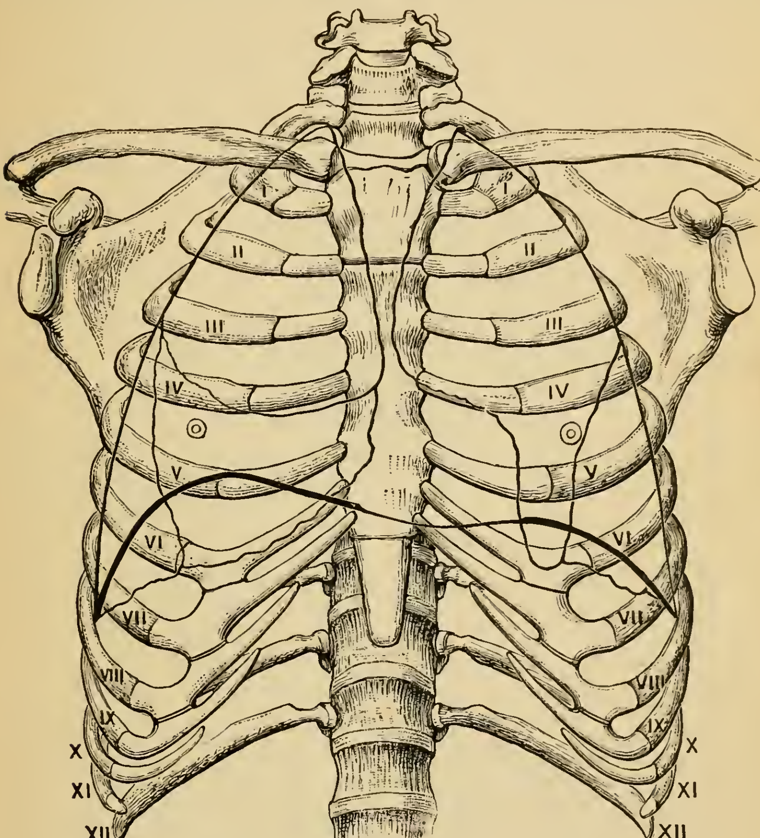


FIG. 65.—ANTERIOR VIEW OF THE THORAX WITH OUTLINES OF THE DIAPHRAGM AND LUNGS. (AFTER MORRIS.)

to the age; lower in the young than the old, and terminates at the tenth or eleventh thoracic spine. The margin of the *left* lung diverges from the mid-sternum, at fourth costo-sternal articulation, horizontally or but slight obliquely to the nipple, then makes a tongue-like projection to the apex of the heart in the

fifth interspace and crosses the sixth costo-chondral articulation; the remaining points of contact being only slightly lower than the right lung, to the tenth or eleventh thoracic spine. The space between the lungs in mid-sternum, it must be remembered, is larger in the child, owing to the existence of the thymus gland. The pleura extends lower down than the margins of the lungs just indicated, in the child as low as the twelfth rib, but in the adult rarely below the eleventh in the axillary line.

In penetrating wounds of the thorax and operations for the evacuation of inflammatory products, these relations should be remembered; but as the sloping of the diaphragm leaves such a thin space between the costal and the diaphragmatic pleura, openings in the axillary line should never be made below the eighth rib. (A. H.)

The dimensions of the right lung are greater than those of the left in all directions except the vertical; the reason of this exception is the greater elevation of the diaphragm on the right side by the liver. On an average the right lung weighs 22 ounces (*623 grm*), the left 20 ounces (*566 grm.*).

The lungs weigh $\frac{1}{37}$ of the total weight in the male, $\frac{1}{42}$ in the female. The specific gravity is 0.7, and, according to some authors, the absolute weight in the male is 1270 grammes (about 45 oz.); in the female, 1030 grammes. In an adult male the cubical dimensions of the lungs are 7000 c.c., *i.e.*, distended to the utmost. The dimensions in extreme expiration, 2500 c.c., or 4500 c.c. less that in extreme inspiration.

The constituents of the root of the lung will be described hereafter when they can be more satisfactorily displayed.

Præcordial Region. — The *præcordial region* is the outline of the heart traced upon the front wall of the chest. It is important for auscultatory purposes that we should know how much of the heart is covered and separated from the wall of the chest by intervening lung (Fig. 64). The following will give a fair indication: "Make a circle of two inches (*5 cm.*) in diameter round a point midway between the nipple and the end of the sternum. (*Masto-Xiphoid line.*) This circle will define, sufficiently for all practical purposes, that part of the heart which lies immediately behind the wall of the chest, and is not covered by lung or pleura." *

This part of the præcordial region is naturally less resonant

* Latham's *Clinical Lectures.*

to percussion, for it is here uncovered, except by pericardium and loose connective tissue, and lies close behind the thoracic wall. In the rest of the præcordial region the heart is covered and separated from the chest wall by intervening lung.

Where should we put the stethoscope when we listen to the valves of the heart? For practical purposes it is enough to

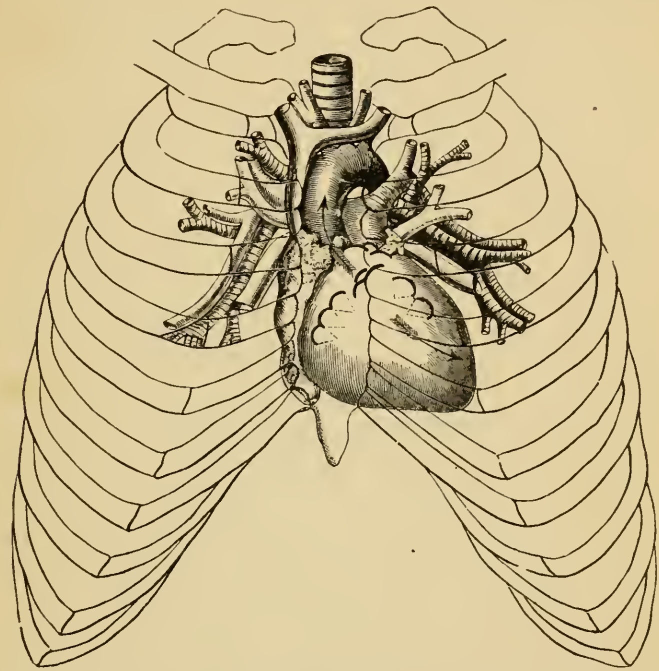


FIG. 66.—RELATIVE POSITION OF THE HEART AND ITS VALVES WITH REGARD TO THE WALLS OF THE CHEST.

The valves are denoted by curved lines. The *aortic valves* are opposite the third intercostal space on the left side, close to the sternum. The *pulmonary valves* are just above the aortic, opposite the junction of the third rib with the sternum. The *mitral valves* are opposite the third intercostal space, about one inch to the left of the sternum. The *tricuspid valves* lie behind the middle of the sternum, about the level of the fourth rib *Aortic murmurs*, as shown by the arrow, are propagated up the aorta; *mitral murmurs*, as shown by the arrow, are propagated towards the apex of the heart.

remember that the mouth of an ordinary sized stethoscope will cover a portion of them all, if it be placed a little to the left of the mesial line of the sternum opposite the third intercostal space (Fig. 64, p. 177). They are all covered by a thin portion of lung; for this reason we ask a patient to stop breathing while we listen to his heart.

Position and Form of the Heart. The heart is situated obliquely in the chest between the lungs. Its base, *i.e.*, the part by which it is attached, and from which its great vessels proceed, is directed upwards towards the right shoulder; its apex points downwards and to the left, between the fifth and sixth costal cartilages. It is supported towards the abdomen, by the tendinous centre of the diaphragm. It is maintained in its position by a membranous bag termed the pericardium, which is lined by a serous membrane to facilitate its movements. The pericardium must first claim our attention.

Pericardium.— The *pericardium* is the conical membranous bag which encloses the heart and the large vessels at its base. It is broadest *below*, where it is attached to the tendinous centre of the diaphragm, and to the muscular part in connection with the tendon, further to the left side than to the right; *above*, it is prolonged over the great vessels of the heart, about two or three inches (*5 to 7.5 cm.*) from their origin, and is connected with the depe cervical fascia. *On each side*, it is in contact with the pleura,* the phrenic nerve running down between them. *In front* of it is the anterior mediastinum; *behind* it is the posterior. Of the objects in the posterior mediastinum, that which is nearest to the pericardium is the œsophagus and the left pneumogastric nerve. It should be remembered that the œsophagus is in close contact with the back of the pericardium and left auricle for nearly two inches (*5 cm.*); this fact accounts for what is sometimes observed in cases of pericarditis where there is much effusion; namely, pain and difficulty in swallowing.

The pericardium is a *fibro-serous* membrane and consists of two layers — an external or fibrous, and an internal or serous. Its *fibrous* layer, a dense membrane, constitutes its chief strength, and is attached, below, to the central tendon and the adjoining muscular part of the diaphragm. Above, it forms eight tubular sheaths for the great vessels at the base of the heart; namely, one for the vena cava superior, four for the pulmonary veins, two for the pulmonary arteries, and one for the aorta. The *serous* layer forms a shut sac. Its parietal layer lines the fibrous layer to which it is intimately attached, and is reflected over the great vessels and the heart to form its visceral layer. To see where the serous layer is reflected over the vessels, distend the

* Some muscular fibres have been pointed out by Dr. W. S. Forbes in the newly-born, passing from the muscular fibres of the diaphram to the base of the fibrous pericardium. — A. H.

pericardium with air. Thus you will find that this layer is reflected over the aorta as high as the commencement of the transverse portion of the arch of the aorta. It is reflected over the front and sides of the vena cava superior.

The serous layer of the pericardium covers the large vessels to an extent greater than is generally imagined; though the extent is not precisely similar in all bodies. The aorta and pulmonary artery are enclosed in a complete sheath, two inches (*5 cm.*) in length, so that these vessels are covered all round by the serous layer, except where they are in contact. Indeed, you can pass your finger behind them both, through a foramen bounded, in front, by the two great vessels themselves; behind, by the upper part of the auricles; and above, by the right pulmonary artery. Again, the back of the aorta, where it lies on the auricles, is covered by the serous pericardium. The superior cava is covered all round, except behind, where it crosses the right pulmonary artery. The inferior cava within the pericardium is partly covered in front. The left pulmonary veins are covered nearly all round; the right less so. Behind the auricles, chiefly the left, the serous layer extends upwards in the form of a pouch, rising above their upper border, so as to be loosely connected to the left bronchus. The object of these serous reflections is to facilitate the free action of the heart and the great vessels at its base.

In the healthy state the capacity of the pericardium nearly corresponds to the size of the heart when distended to its utmost. The healthy pericardium, with the heart *in situ*, may be made to hold, in the adult, about ten ounces of fluid (*295.7 c.c.*). The pericardium is not extensile. When an aneurism bursts into it, death is caused, not by loss of blood, but by compression of the heart in consequence of the inextensibility of the pericardium.

The pericardium derives its blood from the internal mammary, bronchial, and œsophageal arteries; its nerve supply from the phrenic nerves.

On separating the left pulmonary artery and pulmonary vein, you will notice a fold of serous membrane about three-quarters of an inch (*18 mm.*) long, and about one inch (*2.5 cm.*) in depth; this is the *vestigial fold of the pericardium* described by Marshall.* It passes from the side of the left auricle, curving round

* "On the Development of the Great Anterior Veins in Man and Mammalia," *Philosoph. Transactions*; 1850.

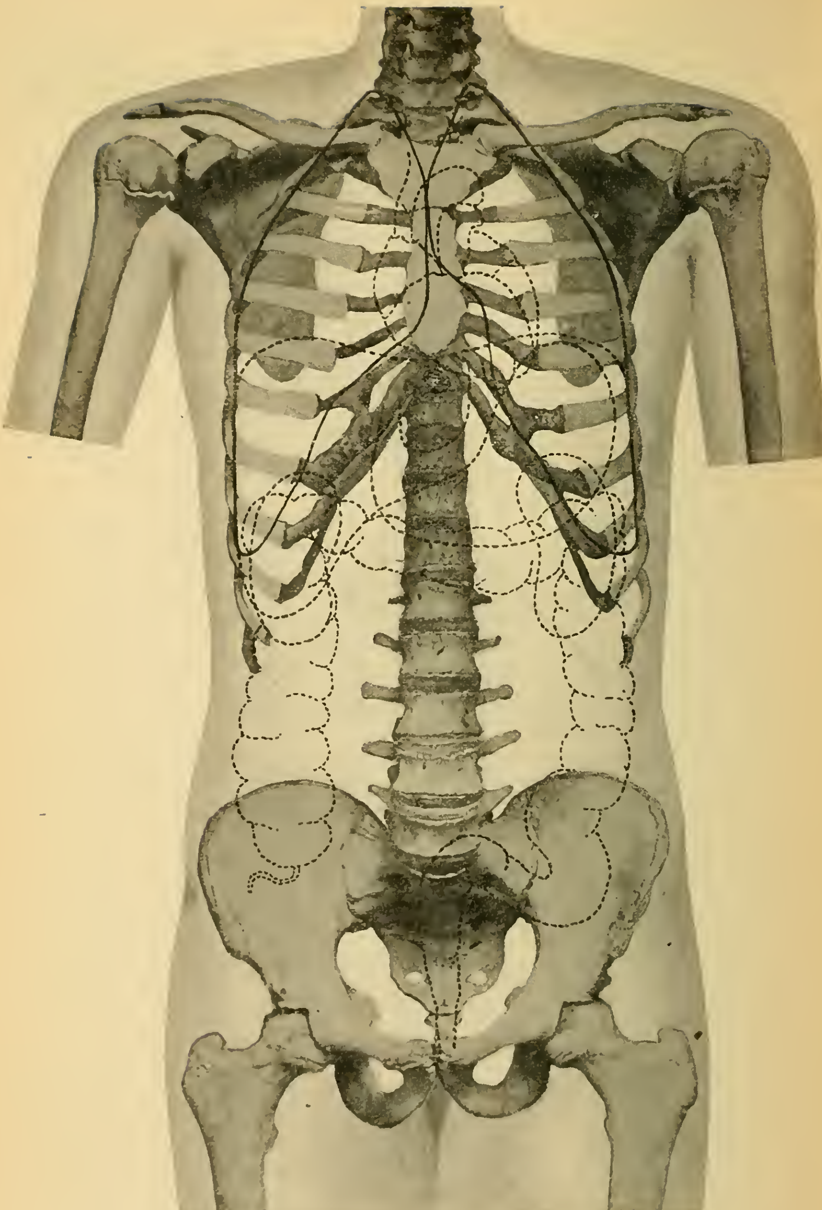


Fig. 67.—Ventral Topography of Viscera of the Thorax and Abdomen.

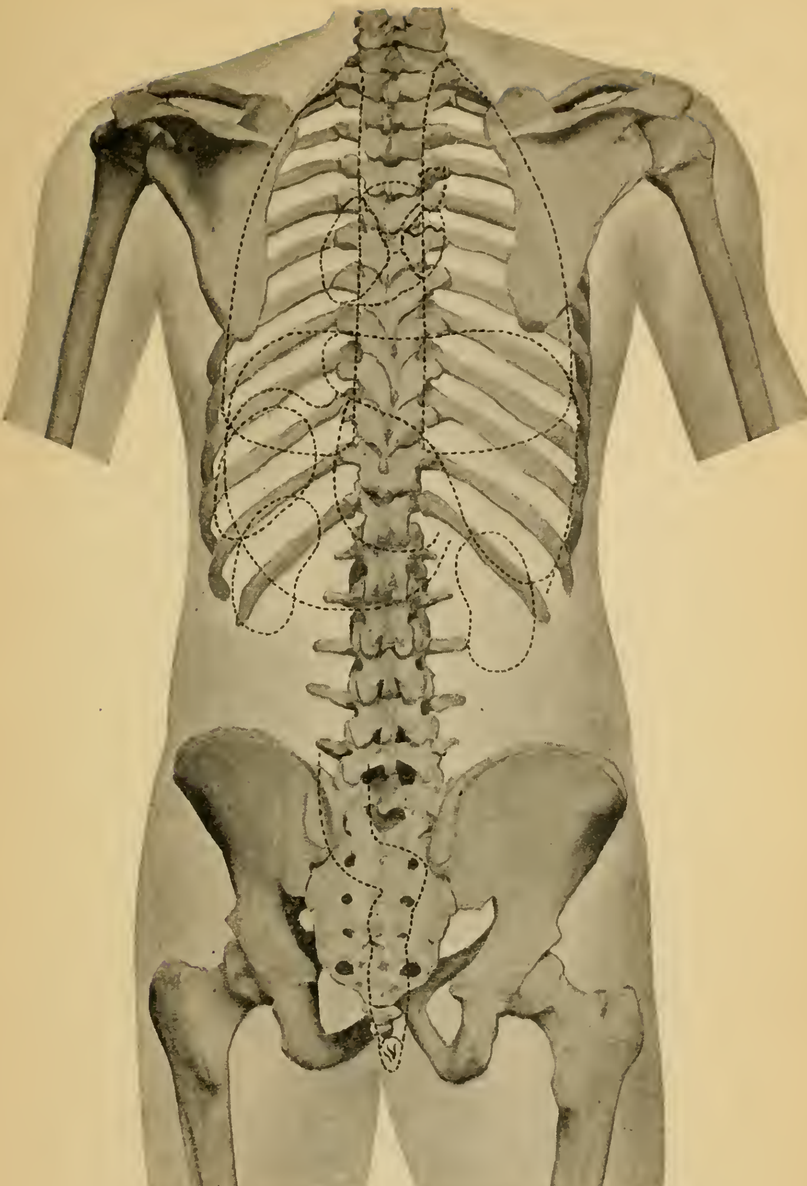


Fig. 68.—Dorsal Topography of Viscera of the Thorax and Abdomen.

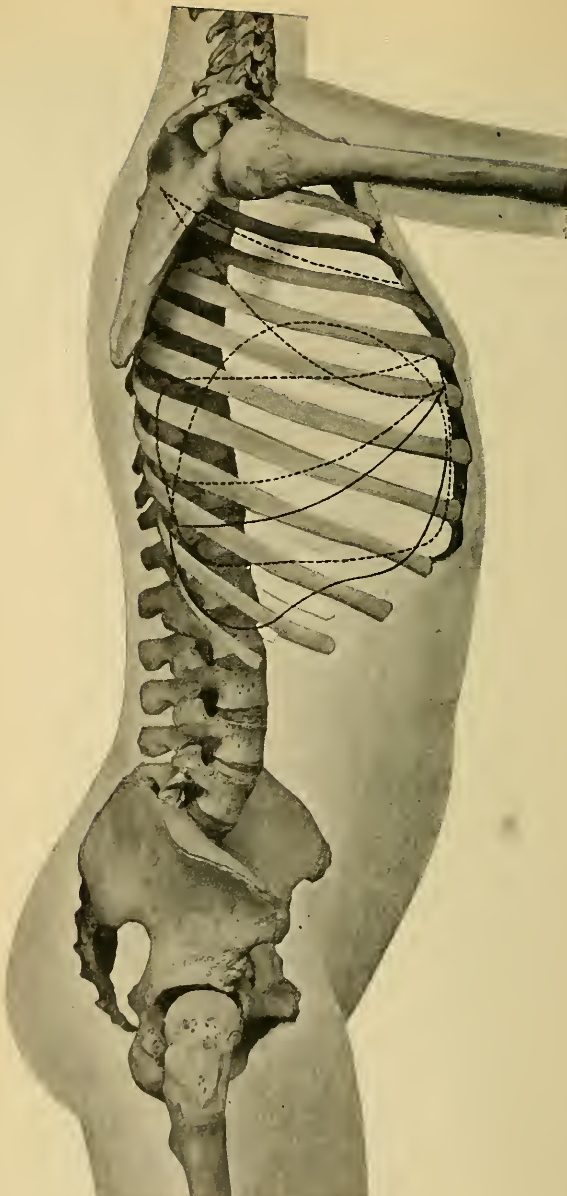


FIG. 69.—RIGHT LATERAL TOPOGRAPHY OF VISCERA OF THE THORAX AND ABDOMEN.

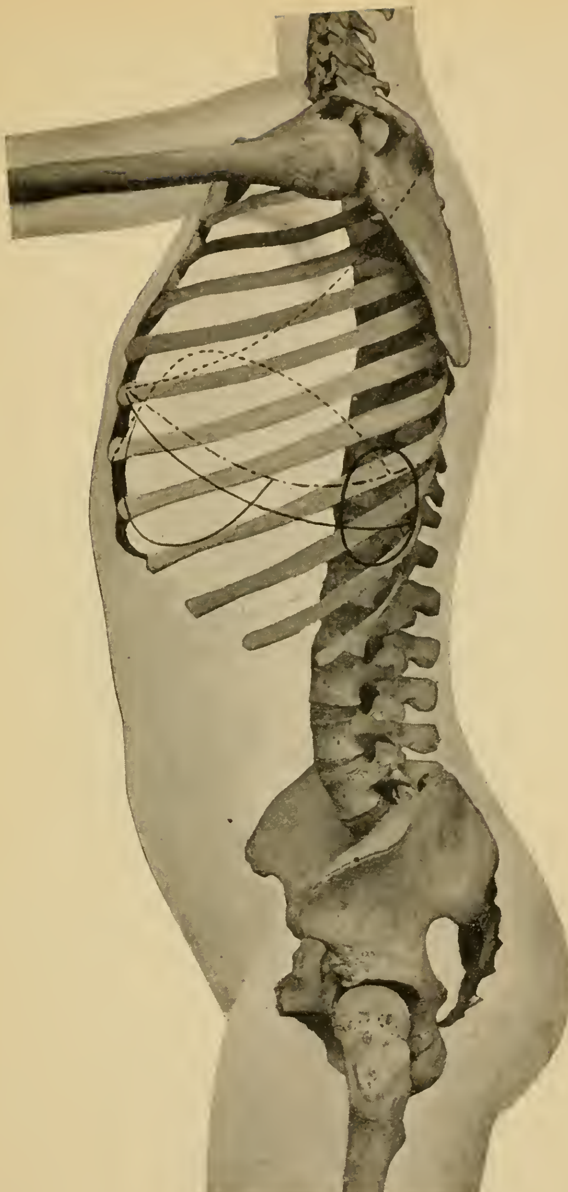


FIG. 70.—LEFT LATERAL TOPOGRAPHY OF VISCERA OF THE THORAX AND ABDOMEN.

the lower left pulmonary vein, to the left superior intercostal vein. It is a vestige of the left v. c. superior (duct of Cuvier), which exists in fœtal life.

Open the pericardium, and observe that the heart is conical in form, and convex everywhere except upon its lower surface, which is flat, and rests upon the tendinous centre of the diaphragm. When the pericardium is thus laid open, the following objects are exposed, viz.: 1. Part of the right ventricle; 2. Part

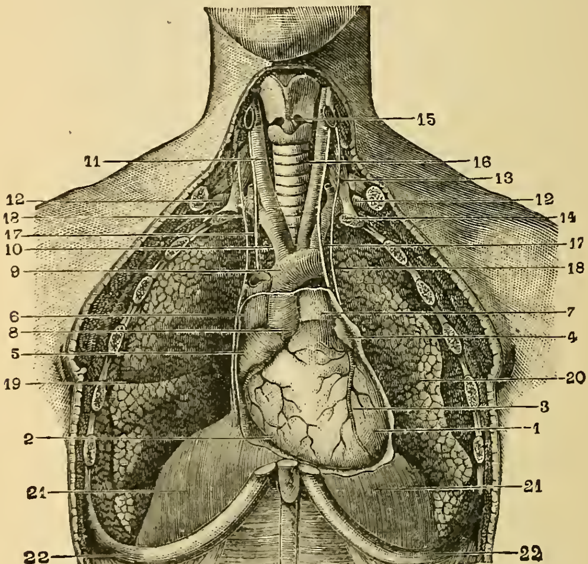


Fig. 71. — Relation of the Pericardium.

1. Left side of the heart. 2. Right side of the heart. 3. Coronary artery. 4. Left auricle. 5. Right auricle. 6. Superior vena cava. 7. Pulmonary artery. 8. Origin of the aorta. 9. Arch of the aorta. 10. Innominate artery. 11. Right common carotid artery. 12. Subclavian arteries. 13. Scalenus anticus muscle. 14. First rib. 15. Larynx. 16. Trachea. 17. Pneumogastric nerve. 18. Phrenic nerve. 19. Right lung. 20. Left lung. 21, 21. Diaphragm. 22, 22, Seventh rib.

of the left ventricle; 3. Part of the right auricle with its appendix overlapping the root of the aorta; 4. The appendix of the left auricle overlapping the root of the pulmonary artery; 5. The aorta; 6. The pulmonary artery; 7. The vena cava superior; 8. The right and left coronary arteries (Fig. 71).

Position of the Heart. — Continued. — The heart, then, placed behind the lower half of the sternum, occupies more of the left than the right half of the chest, and rests upon the ten-

dinous centre of the diaphragm, which is a little below the lowest part of the fifth rib. At each contraction the apex of the heart may be felt beating between the cartilages of the fifth and sixth ribs, about two inches (*5 cm.*) below the nipple and an inch (*2.5 cm.*) to its sternal side, or about three and a half inches (*8.7 cm.*) to the left of the middle of the sternum. Speaking broadly, the base corresponds with a line drawn across the sternum along the upper borders of the third costal cartilages. The right border of the heart is formed almost entirely by the free margin of the right auricle, and, when distended, bulges nearly an inch (*2.5 cm.*) to the right of the sternum. The left border of the heart is formed by the round border of the left ventricle, and reaches from a point, commencing at the second left intercostal space, to a point placed two inches (*5 cm.*) below the nipple and an inch (*2.5 cm.*) to its sternal side. The horizontal border is formed by the sharp margin of the right ventricle, and extends from the sternal attachment of the fifth right costal cartilage to meet the lowest point of the left margin. The base of the heart corresponds posteriorly to the interval between the fifth and the eighth thoracic vertebræ.

The normal position which the cardiac valves hold to the thoracic walls is difficult to define with precision, and this probably accounts for the discrepancies noticed in anatomical works on this subject. The following relations are the results of carefully made observations in the post-mortem room: The *right auriculo-ventricular valves* are situated behind the sternum on the level of the fourth costal cartilage; the *left auriculo-ventricular valves* are opposite the third intercostal space, about one inch (*2.5 cm.*) to the left of the sternum; the cusps of these valves extend as low as the fifth costal cartilage. The *pulmonary valves* lie immediately behind the junction of the third left costal cartilage with the sternum; the *aortic valves* are on a level with the upper border of the third intercostal space just at the left of the middle line of the sternum.*

The position of the heart varies a little with the position of the body. Of this any one may convince himself by leaning alternately forwards and backwards, by lying on this side and on that, placing at the same time his hand upon the præcordial region. He will find that he can, in a slight degree, alter the

* Anatomists differ much in the description they give of the relations of the valves to the thoracic walls; in fact no two agree in all the details.

place and the extent of the impulse of the heart. Inspiration and expiration also alter the position of the heart.

The student should now make out the large vessels in connection with the base of the heart, leaving the consideration of this organ to a later stage of the dissection.

Before we can display the brachio-cephalic veins, the layer of the deep cervical fascia must be removed, which descends over them from the neck and is lost upon the pericardium. Their coats are intimately connected with this fascia; and one of its functions appears to be to keep the veins permanently open for the free return of blood to the heart.

Brachio-Cephalic Veins. — The *right* and *left brachio-cephalic* (innominate) *veins* are formed, near the sternal end of the clavicle, by the confluence of the internal jugular and subclavian veins. They differ in their course and relations, and must, therefore, be described separately.

The *left brachio-cephalic vein* passes from the left side obliquely behind the first bone of the sternum, the sterno-hyoid and thyroid muscles, the remains of the thymus gland, towards the right side, to form with the right innominate vein the vena cava superior (Fig. 72, p. 191). It is about three inches (*7.5 cm.*) in length, and its direction inclines a little downwards. It is larger than the right brachio-cephalic, and crosses over the trachea and the origins of the three primary branches of the arch of the aorta. We are reminded of this fact in some cases of aneurism of these vessels — for what happens? The vein becomes compressed between the aneurism and the sternum; hence the swelling and venous congestion of the parts from which it returns its blood; namely, of the left arm, and the left side of the neck. The upper border of the vein is not far from the upper border of the sternum: in some cases it lies even higher, and we have seen it crossing in front of the trachea fully an inch (*2.5 c.m*) above the sternum. This occasional deviation should be borne in mind in the performance of tracheotomy.

The *right brachio-cephalic vein* descends nearly vertically to join the superior vena cava, opposite the first right intercostal space. It is about an inch and a half (*3.7 cm.*) in length, and is situated about one inch (*2.5 cm.*) from the mesial line of the sternum. On its left side, but on a posterior plane, runs the arteria innominata; on its right side is the pleura (Fig. 72, p. 191). Between the vein and the pleura is the phrenic nerve. The brachiocephalic veins are not provided with valves. The veins

which generally empty themselves into the right and left brachio-cephalic are as follows : —

The Right B.-C. Vein receives —	The Left B.-C. Vein receives —
The vertebral	The vertebral
The internal mammary.	The internal mammary.
The inferior thyroid.	The inferior thyroid.
	The superior intercostal.
	The pericardiac.
	The thymic.

Opening into the point of junction of the internal jugular and subclavian veins, on the right side is the right lymphatic duct ; on the left side is the thoracic duct.

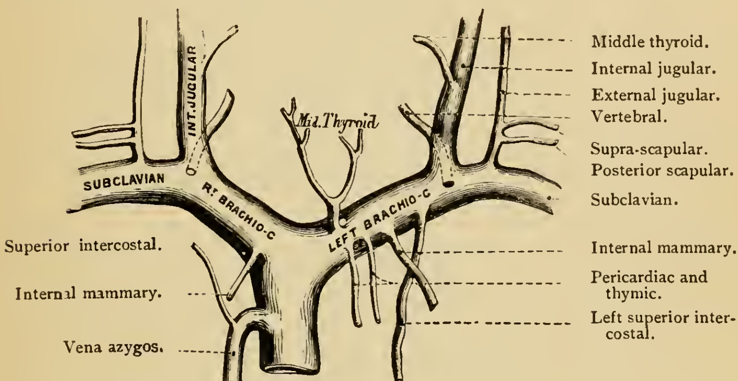


Fig. 72. — Superior Vena Cava and its Tributaries.

Vena Cava Superior.* — This is the great vein through which the impure blood from the head, upper extremities, and chest returns into the right auricle. It is formed by the junction of the right and left brachio-cephalic veins, which unite at nearly a right angle opposite the upper part of the first intercostal space on the right border of the sternum ; that is, about the level of the highest point of the arch of the aorta. The vena cava descends vertically, with a slight inclination backwards, to the upper and anterior part of the right auricle. It is from two and a half to three inches (*6.2 to 7.5 cm.*) long, and has no valves. The lower half of it is covered by the pericardium ; you must, therefore, open this sac to see how the serous layer of the pericardium is reflected over the front and sides of the vein. In

* *Cephal cava.*

respect to its relations, notice that the vein lies in front of the right bronchus and the right pulmonary vessels; and that it is overlapped by the ascending aorta, which lies to its left side. In the upper half of its course, that is, above the pericardium, it is covered on its right side by the pleura; on this side, in contact with it, descends the phrenic nerve.

Before it is covered by the pericardium, the vena cava receives the right veno azygos, which opens into it after hooking over the right bronchus; also some pericardiac and mediastinal veins.

Course of the Aorta. — The aorta is the great trunk from which all the arteries of the body carrying arterial blood are derived. It commences at the upper and back part of the left ventricle of the heart. It ascends forwards and to the right as high as the lower border of the first intercostal space on the right side; it then arches backwards towards the left side of the body of the second thoracic vertebra, and turning downwards over the left side of the third, completes the arch at the fifth thoracic vertebra. The aorta descends through the thorax on the left side of the bodies of the remaining thoracic vertebræ as far as the diaphragm; it enters the abdomen through the aortic opening of the diaphragm, and descends as far as the left side of the body of the fourth lumbar vertebra, where it bifurcates into the right and left common iliac arteries. The aorta has received different names in the various parts of its course; thus, the arched portion extending from its origin at the left ventrical to the fifth thoracic vertebra, is called the *arch of the aorta;* the portion between this vertebra and the diaphragm is the *descending thoracic aorta;* and the remainder of its course to its division at the fourth lumbar vertebra is known as the *abdominl aorta.*

Course and Relations of the Arch of the Aorta. — The arch of the aorta, as before stated, commences at the upper part of the left ventricle, and describes an arch which terminates at the fifth thoracic vertebra. Its origin is situated behind the pulmonary artery, and on the left side of the middle of the sternum, about the level of the lower border of the third costal cartilage. The direction of the arch, therefore, is from the sternum to the spine and rather obliquely from right to left.

For convenience of description, the arch of the aorta is divided into an ascending, a transverse, and a descending portion.

Ascending Portion. — To see this portion of the aorta, the pericardium must be opened. You then observe that this part of the artery is enclosed all round by the serous layer of the

pericardium, except where it is in contact with the pulmonary artery. It is about two inches (*5 cm.*) in length, and ascends with a slight curve, the convexity looking forwards and to the right side, as far as the upper border of the second costal cartilage of the right side, where it lies almost in contact with

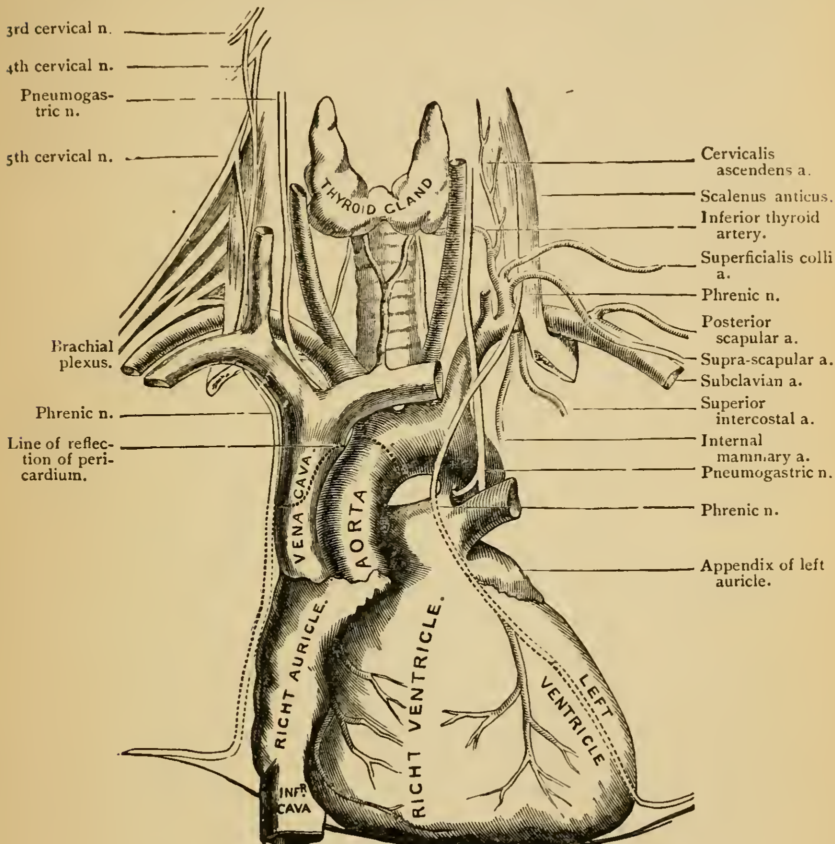


FIG. 73.

the sternum. Its commencement is *covered* by the pulmonary artery, and is overlapped by the appendix of the right auricle, and higher up by the remains of the thymus gland. On its *right side*, but on a posterior plane, is the superior vena cava and the right auricle; on its *left side* is the pulmonary artery; *behind it* are part of the right auricle, the right pulmonary artery

and vein, and the root of the right lung. This part of the arch gives off the right and left coronary arteries for the supply of the heart.

The right border of the ascending portion of the arch bulges to the right of the sternum to the extent of a quarter of an inch (*6 mm.*), and may be seen at the sternal end of the second right intercostal space.

The arch of the aorta presents partial dilatations in certain situations. One of these, called the *great sinus of the aorta*, is observed on the right side of the arch, about the junction of the ascending with the transverse portion ; it is little marked in the infant, but increases with age. Three other dilatations (the *sinuses of Valsalva*), one corresponding to each of the valves at the commencement of the aorta, will be examined hereafter.

Transverse Portion. — This portion of the aorta arches from the front to the back of the thorax, and extends from the upper border of the second right costal cartilage to the left side of the third thoracic vertebra. Its highest convex portion ascends usually to about an inch (*2.5 cm.*) below the upper border of the sternum, and its concavity corresponds with the articulation of the first and second bones of the sternum. *In front* it is covered by the left pleura and lung, and is crossed by the left phrenic, the left pneumogastric, the superficial cardiac nerves, the pericardiac, and the left superior intercostal veins. Near its *summit* runs the left brachio-cephalic vein. Within its *concavity* are the left bronchus, the bifurcation of the pulmonary artery, the left recurrent laryngeal nerve, and the remains of the ductus arteriosus. The artery *rests* upon the trachea (a little above its bifurcation), the deep cardiac plexus, the œsophagus, the thoracic duct, and the left recurrent laryngeal nerve. From the upper part of the transverse portion of the arch arise the arteria innominata, the left carotid, and the left subclavian arteries ; and lying in front of these arteries is the left brachio-cephalic vein.

Descending Portion. — This part of the arch lies upon the left side of the body of the fourth thoracic vertebra, and at the lower border of the body of the fourth, or the upper part of the fifth, thoracic it takes the name of the descending thoracic aorta. On its *right side* are the œsophagus and thoracic duct ; on its *left* is the pleura ; *in front* are the pleura and the root of the left lung ; *behind*, it lies on the anterior common ligament, corresponding to the fourth thoracic vertebra.

What parts are contained within the arch of the aorta ? –

The left bronchus, the right pulmonary artery, the left recurrent nerve, the remains of the ductus arteriosus, and the superficial cardiac plexus of nerves.

Relations of the Arch of the Aorta to the Sternum.—These relations vary according to the size of the heart, the obliquity of the ribs, and the general development of the chest. In a well-formed adult the ascending aorta is, at the most prominent part of its bulge, about half an inch (*12.5 mm.*) behind the first bone of the sternum. The highest part of the arch is about one inch (*2.5 cm.*) below the upper edge of the sternum.*

The branches given off from the ascending portion of the arch are the right and left coronary arteries, which pass, one in front of, and the other behind, the heart to supply its muscular tissue.

The *right coronary artery* arises from the anterior sinus of Valsalva, and passes to the right between the pulmonary artery and the right auricular appendix, running in the auriculo-ventricular groove.

The *left coronary artery*, larger than the preceding, is given off from the left posterior sinus of Valsalva, and passes between the pulmonary artery and left auricular appendix; it runs down in the anterior interventricular sulcus towards the apex of the heart.

The further description of these vessels will be considered in the dissection of the heart.

From the highest part of the arch arise three large arteries for the head, neck, and upper limbs; namely, the brachio-cephalic or innominate artery, the left carotid, and the left subclavian.

Brachio-cephalic or Innominate Artery.—This, the largest of the three, arises from the commencement of the transverse part of the arch. It ascends obliquely towards the right, and, after a course of about one inch and a half to two inches (*37.5 mm. to 50 mm.*), divides behind the right sterno-clavicular joint into two arteries of nearly equal size—the right subclavian and the right common carotid.

* The relations of the arch of the aorta to the sternum vary even in adults, more especially if there be any hypertrophy of the heart. As an instance among many, we may mention that of a young female who died of phthisis. The position of the aortic valves was opposite the middle of the sternum, on a level with the middle of the second costal articulation. The highest part of the arch was on a level with the upper border of the sternum; the arteria innominata was situated entirely in front of the trachea; and the left brachio-cephalic vein crossed the trachea so much above the sternum that it would have been directly exposed to injury in tracheotomy.

The relations of the innominate artery are as follow: *In front* it has the manubrium sterni, the right sterno-clavicular joint, the origins of the sterno-hyoid and thyroid muscles, the remains of the thymus gland, the left brachio-cephalic vein, the right inferior thyroid vein, and the right inferior cervical cardiac branch of the pneumogastric nerve. *Behind*, it rests upon the trachea. On its *left side* are the left common carotid and the remains of the thymus. On its *right side* are the lung and pleura, the right brachio-cephalic vein, and the pneumogastric nerve.

With the anatomy of the parts before you, you can understand that an aneurism of the innominate artery might be distinguished from an aneurism of the aorta — 1. By a pulsation in the neck between the sterno-mastoid muscles, *i.e.*, in the fossa above the sternum; 2. By occasional dyspnœa owing to pressure on the trachea; 3. By venous congestion in the *left* arm; 4. By the aneurismal thrill being confined to the *right* arm.*

Left Common Carotid Artery. — This artery arises from the arch of the aorta, close to, and to the left of, the arteria innominata. It ascends obliquely to the left sterno-clavicular joint, and thence to the neck, where its course nearly corresponds with the right common carotid (p. 98). *In front* it has the sternum, the left sterno-hyoid and thyroid muscles, the left brachio-cephalic vein, and the remains of the thymus gland; *behind*, it has at first the trachea, and higher up the œsophagus and thoracic duct; to the *right side* is the innominate artery; to the *left side* are the left subclavian artery and left pneumogastric nerve.

Left Subclavian Artery. — This is the third branch of the transverse part of the arch, and arises from it opposite the third thoracic vertebra. It ascends nearly vertically out of the chest to the inner border of the first rib, and then curves outwards behind the scalenus anticus. *In front* it has the lung covered with pleura, the pneumogastric, phrenic, and cardiac nerves, the left common carotid, the left internal jugular, and the left innominate veins, the sterno-hyoid, sterno-thyroid, and sterno-

* If the innominate artery be ligatured, the circulation would be maintained by the following collateral branches: 1. Between the branches of the two external carotids, which anastomose across the middle line. 2. Between the aortic intercostal and the superior intercostal. 3. Between the aortic intercostals and the internal mammary, long thoracic, alar thoracic, and subscapular arteries. 4. Between the internal mammary and deep epigastric. 5. Between the inferior thyroid arteries. 6. Between the two vertebrals. 7. Between the two internal carotid arteries.

mastoid muscles. To its *right side* are the left carotid, œsophagus, and trachea; between the artery and the œsophagus is the thoracic duct; to its *left side* is the lung covered with pleura; *behind it* are the longus colli muscle covering the vertebræ, the œsophagus, thoracic duct, and the inferior cervical ganglion of the sympathetic. The upper part of its course, where the vessel passes in front of the apex of the lung, has been described with the anatomy of the neck (p. 130).

Course of the Phrenic Nerves through the Chest. — The *phrenic nerve* comes from the third, fourth, and fifth cervical nerves, but chiefly from the fourth. It descends on the scalenus anticus, gradually inclining to its inner border, and enters the chest between the subclavian vein and artery. It then crosses over the internal mammary artery and runs in front of the root of the lung, between the pleura and the pericardium to the diaphragm (Fig. 73, p. 193), to the under surface of which it is distributed.

The phrenic nerve is joined on the scalenus anticus by an offset from the fifth cervical branch of the brachial plexus; by another filament from the sympathetic nerve; and very frequently by a small loop from the nerve to the subclavius muscle; occasionally also by a branch from the descendens hypoglossi.

In what respects do the phrenic nerves differ from each other in their course? The right phrenic runs along the outer side of the brachio-cephalic vein and superior vena cava; the left crosses in front of the transverse part of the arch of the aorta; besides which, the left is rather longer than the right, since it curves over the apex of the heart.

Before the phrenic nerve divides into branches to supply the diaphragm, it sends off minute filaments to the pleura and the pericardium; after it has pierced the diaphragm it distributes branches to the peritoneum. The *right* phrenic gives off one or two filaments, which unite with some filaments from the solar plexus and form a small ganglion, from which branches are distributed to the supra-renal capsule, the hepatic plexus, and the inferior vena cava. The *left* phrenic gives off a branch which joins a twig from the sympathetic near the œsophageal opening of the diaphragm, but there is no appearance of a ganglion.

Having studied these anatomical details, consider for a moment what symptoms are likely to be produced by an aneurism of the arch of the aorta, or any of the primary branches. A glance at the important parts in the neighborhood helps to answer the question. The effects will vary according to the part of the artery which is the seat of the aneurism, and according to the size, the form, and the

position of the tumor. One can understand that compression of the vena cava superior, or either of the brachio-cephalic veins, would occasion congestion and œdema of the parts from which they return the blood; that compression of the trachea or one of the bronchi might occasion dyspnœa, and thus simulate disease of the larynx; * that compression of the œsophagus would give rise to symptoms of obstruction. Nor must we forget the immediate vicinity of the thoracic duct and the recurrent nerve,† and the effects which would be produced by their compression. Can one, then, be surprised that a disease which may give rise to so many different symptoms should be a fertile source of fallacy in diagnosis?

Thus you can understand how aneurisms of the aorta may prove fatal by bursting into the contiguous tubes or cavities; for instance, into the trachea, the œsophagus, the pleura, or the pericardium. You will see, too, why an aneurism of the first part of the arch is so much more dangerous than elsewhere. The reason is, that in this part of its course the aorta is covered only by a thin layer of serous membrane. If an aneurism takes place here, the coats of the vessel soon become distended, give way, and allow the blood to escape into the pericardium — an occurrence which is speedily fatal, because, the pericardium being filled with blood, the heart is prevented from acting.

Posterior Mediastinum and its Contents. — The posterior mediastinum (p. 176) is formed by the reflection of the pleural sac on each side, from the root of the lung to the sides of the bodies of the thoracic vertebræ. It is bounded in front by the pericardium and the roots of the lungs. To obtain a view of it, cut away the ribs nearly as far as their angles, draw out the right lung towards the left side, and fasten it firmly to the left side of the thorax. Remove the pleura of the right side from the ribs, and the posterior aspect of the root of the right lung, and then by a little careful dissection the space and the structures contained in it will be displayed. This mediastinum contains the descending thoracic aorta with some of the right aortic intercostal arteries; in front of the aorta, the œsophagus, with the pneumogastric nerves, the left in front and the right behind; on the right of the aorta is the vena azygos major, between this vein and the aorta is the thoracic duct; superiorly is the trachea; inferiorly are the splanchnic nerves and some lymphatic glands. To expose these last we must remove the pleura and a layer of dense fascia which lines the chest outside it.

Descending Thoracic Aorta. — We have already traced the arch of the aorta to the body of the fifth thoracic vertebra (p. 194). From this point the aorta descends on the left side of the spine, gradually approaching towards the middle line. The artery, moreover, following the thoracic spinal curve, is not ver-

* In the Museum of Guy's Hospital there is a preparation, No. 1,487, in which laryngotomy was performed under the circumstances described in the text.

† See *Med. Gaz.*, Dec. 22, 1843: a case in which loss of voice was produced by the pressure of an aneurismal tumor upon the left recurrent nerve.

tical, but concave forwards. Opposite the last thoracic vertebra it passes between the crura of the diaphragm and enters the abdomen. It is contained in the posterior mediastinum; on its *left side* it is covered with pleura enclosing the left lung, and below it has the œsophagus to the left; on its *right* run the vena azygos, the œsophagus, and thoracic duct; *in front* of it are the root of the left lung and the pericardium. Lower down the œsophagus is in front of the artery, and subsequently lies a little to its left side; *behind* are the vertebral column and the vena azygos minor. Its branches will be described presently.

Vena Azygos Major.—This vein commences in the abdomen opposite the first or second lumbar vertebra, by small branches from one of the lumbar veins of the right side, and generally communicates with the renal, or the vena cava itself. This, indeed, is the main point about the origin of the vena azygos, that it communicates directly or indirectly with the vena cava inferior. It enters the chest through the aortic opening of the diaphragm, and ascends on the right side of the aorta through the posterior mediastinum, in front of the bodies of the lower thoracic vertebræ, and over the right intercostal arteries. When the vein reaches the level of the third thoracic vertebra it arches forwards over the right bronchus, and terminates in the superior vena cava, just before this vessel is covered by pericardium. In its course it receives nine or ten of the lower intercostal veins of the right side, the spinal veins, the posterior mediastinal, the œsophageal,

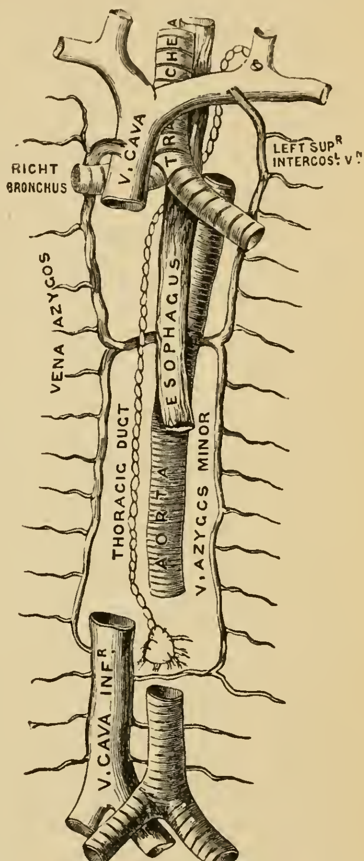


Fig. 74.—Diagram to show the Course of the Vena Azygos and the Thoracic Duct.

and the right bronchial veins. Opposite the sixth or seventh thoracic vertebra it is joined by the left vena azygos. It is occasionally connected with the right superior intercostal vein.

The left vena azygos, *vena azygos minor*,* runs up the *left* side of the spine. This vein commences in the abdomen from one of the lumbar veins of the left side, or from the left renal. It then ascends on the left side of the aorta through the left crus of the diaphragm. On a level with the sixth or seventh thoracic vertebra it passes beneath the aorta and thoracic duct to join the azygos major. Before passing beneath the aorta it usually communicates with the left superior intercostal vein. It generally receives six or seven of the lower intercostal veins of the left side, the œsophageal and mediastinal veins. These azygos veins are provided with imperfect valves, and are supplemental to the inferior vena cava.

The *left upper azygos vein* † receives the intercostal vein of the left side, usually from the fourth to the sixth; it communicates above with the left superior intercostal vein, and opens below, either directly into the vena azygos major, or indirectly into it through the vena azygos minor.

Thoracic Duct and Receptaculum Chyli. — The *thoracic duct* (Fig. 74) is a canal, from fifteen to eighteen inches (*37.5 to 45 cm.*) long, through which the contents of the lacteal vessels from the intestines and the lymphatics from the lower limbs are conveyed into the blood. These vessels converge to an oval dilatation, termed *receptaculum chyli* (cistern of Pecquet), situated a little to the right side of the front of the body of the second lumbar vertebra, behind the aorta and close to the right crus of the diaphragm. Then, getting to the right side of the aorta, it ascends through the aortic opening of the diaphragm into the chest, and runs up the posterior mediastinum, still along the right side of the aorta, between this vessel and the vena azygos major, and opposite the sixth thoracic vertebra crosses over the vena azygos minor. Near the *third* thoracic vertebra it inclines to the left side, and then passes behind the arch of the aorta and the œsophagus, and ascends on the left side of this tube, between it and the left pleura; subsequently the duct passes up between the œsophagus and the left subclavian artery, as high as the seventh cervical vertebra, resting on the longus colli. It

* This may be called *lower* (caudal) *left azygos* and *vena hemiazygos*. — A. H.

† This may be called vena azygos tertia, or vena (cephal) hemiazygos accessoria. — A. H.

then emerges from beneath the carotid sheath, curves downwards over the subclavian artery, in front of the scalenus anticus, and opens into the back part of the confluence of the left internal jugular and subclavian veins. The orifice of the duct is guarded by two valves which permit fluid to pass from the duct into the vein, but not *vice versâ*. Valves, disposed like those in the venous system, are placed at short intervals along the duct, more numerous in its upper part, so that its contents can only pass upwards.* The diameter of the duct varies in different parts of its course; at its commencement it is about one-fourth of an inch (*6 mm.*) in diameter, at the sixth thoracic it is about one-sixth of an inch (*4 mm.*), and it enlarges again towards the termination. It receives the lymphatics from the lower extremities, and from all the abdominal viscera (except the convex surface of the liver and the abdominal walls); above these it receives the lymphatics from the left side of the thorax, the left lung, the left side of the heart, the left upper extremity, and the left side of the head and neck.

Œsophagus. — The *œsophagus* is that part of the alimentary canal which conveys the food from the pharynx to the stomach. It commences at the lower border of the fifth cervical vertebra, at the back of the cricoid cartilage; runs down in front of the spine, to the right side of the transverse portion of the arch of the aorta, then through the posterior mediastinum in front of the descending aorta, and passes through the œsophageal opening in the diaphragm to end in the stomach, opposite the ninth thoracic vertebra. It is from nine to ten inches (*22.5 to 25 cm.*) long. Its course is not exactly straight, for it describes three curves — one an antero-posterior, the other two lateral curves. In the neck at its commencement it lies at first in the middle line; it then gets behind, and a little to the left of the trachea; in the chest, *i.e.*, about the fourth thoracic vertebra, it inclines towards the right side to make way for the aorta; but it again inclines to the left before it passes through the diaphragm. Its antero-posterior curve corresponds to the curve of the spinal column.

The œsophagus, in the neck, rests *behind*, upon the front of

* The thoracic duct varies in size in different individuals. It may divide in its course into two branches, which subsequently reunite; instead of one there may be several terminal orifices. Instances have been observed in which the duct has terminated on the right instead of the left side (Fleischmann, *Leichenöffnungen*, 1815; also Morrison, *Journal of Anat.*, vol. vi, p. 427). It has been seen to terminate in the vena azygos (Muller's *Archiv*, 1834).

the spine covered by the longus colli muscle; in *front* it has the trachea; on *each side* it is in relation with the thyroid body, the common carotid (chiefly the left), and inferior thyroid arteries, and the recurrent laryngeal nerves; to the *left* of it is the thoracic duct.

In the thorax, the œsophagus has, *in front*, the trachea, the left bronchus, the arch of the aorta, the left carotid, and left subclavian arteries; and, lastly, for about two inches (*5 cm.*), the posterior surface of the pericardium (behind the left auricle); this accounts for the pain which is sometimes experienced, in cases of pericarditis, during the passage of food; *behind*, it rests upon the spinal column, the longus colli, the thoracic duct, the third, fourth, and fifth intercostal arteries of the right side; and, lastly, it lies in front of and slightly to the left side of the aorta; *laterally*, the aorta and pleura are to the *left*, and the vena azygos major to the *right* of the tube. As it passes down in the inter-pleural space, it is in connection with both pleuræ. The œsophagus is surrounded by a plexus of nerves formed by the pneumogastric nerves, the left being in front of, the right behind it.

The œsophagus is supplied with blood by the inferior thyroid, the œsophageal branches of the aorta, the coronaria ventriculi, and the left phrenic artery. It is supplied with nerves by the pneumogastric and the sympathetic, which ramify between the two muscular layers. The œsophagus is composed of three coats, an external or muscular, a middle or areola, and an internal or mucous. The muscular coat consists of an outer longitudinal, and an inner circular layer of fibres. The longitudinal layer is particularly strong, and arranged in the upper part mainly in three fasciculi, an anterior attached to the vertical ridge on the cricoid cartilage, and two lateral, which are continuous with the inferior constrictor; these, lower down, spread out and form a continuous layer round the œsophagus and support the circular fibres. Under the microscope the muscular fibres composing the upper part are seen to consist entirely of the striped variety; at the lower part, almost exclusively of the non-striped variety. The middle coat is composed of areolar tissue, and connects very loosely the muscular and mucous coats, thereby allowing the mucous membrane to move very freely in its muscular envelope. The mucous membrane is of a pale color and considerable thickness, and in the contracted state of the œsophagus is arranged in longitudinal folds within the tube, which lies flattened in front

of the spine. On the surface of the mucous membrane there are numerous minute papillæ placed obliquely. It is lined by a very thick layer of scaly epithelium. In the submucous tissue are many small compound racemose glands — *œsophageal glands* — especially towards the lower end of the œsophagus.

Course and Branches of the Pneumogastric Nerves. — The course of the pneumogastric nerves in the chest is not the same on both sides. The *right* pneumogastric nerve enters the chest between the subclavian artery and vein, descends behind the right innominate vein by the side of the trachea to the back of the root of the lung, where it breaks up into a plexus forming the posterior pulmonary plexus. From this plexus two cords descend to the posterior surface of the œsophagus, upon which they divide into numerous branches; forming, with corresponding branches of the left pneumogastric nerve, the œsophageal plexus *(plexus gulæ)*. The plexus then reunites into a single trunk, consisting also of some fibres from the left pneumogastric, and passes into the abdomen through the œsophageal opening in the diaphragm. The *left* pneumogastric descends into the chest between the left subclavian and carotid arteries, and behind the left brachio-cephalic vein. It then crosses in front of the arch of the aorta, and passes behind the root of the left lung to the anterior surface of the œsophagus, upon which it also assists to form a plexus with the nerve of the right side. The branches of the pneumogastric nerve in the chest are as follow:—

a. The inferior laryngeal or recurrent. — This nerve on the right side turns under the subclavian and the common carotid arteries (Fig. 73, p. 193); on the left, under the arch of the aorta, below the ductus arteriosus, and ascends to the larynx. It passes beneath the inferior thyroid artery, and lying in the groove between the trachea and œsophagus, it enters the larynx beneath the lower border of the inferior constrictor of the pharynx. It supplies with motor nerves all the muscles which act upon the rima glottidis, except the crico-thyroid (supplied by the external laryngeal nerve). As they turn beneath their respective arteries, they give off branches to the deep cardiac plexus; also some small filaments to the inferior cervical ganglion of the sympathetic. In the neck it distributes small branches to the trachea, œsophagus, and inferior constrictor muscle.

b. Cardiac branches. — These are very small, and join the cardiac plexuses (Fig. 60, p. 161); the right arise from the right pneumogastric, and the right recurrent laryngeal, close to the trachea; the left come from the left recurrent laryngeal nerve. On both sides these branches pass to the deep cardiac plexus.

c. Pulmonary branches. — These accompany the bronchial tubes. The greater number run behind the root of the lung and constitute the *posterior* pulmonary plexus. A few, forming the *anterior* pulmonary plexus, supply the front part of the root of the lung. Both these plexuses are joined by filaments from the second, third, and fourth thoracic ganglia of the sympathetic. The nerves of the lungs are, however, very small, and cannot be traced far into their substance.*

* Upon this subject, see the beautiful plates of Scarpa.

d. Œsophageal plexus. — Below the root of the lung each pneumogastric nerve is subdivided so as to form an interlacement of nerves round the œsophagus *(plexus gulæ).* From this plexus numerous filaments supply the coats of the tube; but the majority of them are collected into two nerves — the one, chiefly the continuation of the left pneumogastric nerve, lying in front of the œsophagus; the other, chiefly that of the right, lying behind it. Both nerves pass through the œsophageal opening in the diaphragm for the supply of the stomach, the left also sending filaments to join the hepatic plexus; the right sending branches to the cœliac, splenic, and left renal plexuses.

Having examined the contents of the posterior mediastinum from the right side, now do so from the left. The left lung should be turned out of its cavity and fastened by hooks towards the right side. After removing the pleura, we see the descending thoracic aorta, the pneumogastric nerve crossing the arch and sending the recurrent branch under it; also the first part of the left subclavian, covered externally by the pleura. The pneumogastric nerve must be traced behind the root of the left lung to the œsophagus, and the œsophageal plexus of this side dissected. Lastly, notice the lesser vena azygos, which crosses under the aorta about the sixth or seventh thoracic vertebra to join the vena azygos major.

Thoracic Portion of the Sympathetic. — This portion of the sympathetic system is generally composed of twelve ganglia covered by the pleura, one ganglion being found over the head of each rib, except the last two, which lie on the side of the bodies of the vertebræ. Often there are only ten ganglia, in consequence of two of them being fused here and there. The first thoracic ganglion is the largest.

The ganglia are connected together by thick branches, and each ganglion is connected *externally* by two branches with the corresponding intercostal nerves. The nerves proceeding from the ganglia pass inwards to supply the thoracic and part of the abdominal viscera. The *internal* branches which proceed from the six upper ganglia are small, and are distributed as follows (Fig. 75, p. 205): —

a. Minute nerves from the first and second ganglia to the deep *cardiac plexus.*

b. Minute nerves from the third and fourth ganglia to the *posterior pulmonary plexus.*

The branches arising from the six lower ganglia unite to form three nerves — the *great splanchnic*, the *lesser*, and the *smallest splanchnic nerves.*

a. The *great splanchnic* nerve is generally formed by branches from the fifth or sixth to the tenth ganglion, and also receiving filaments, according to Beck, from

all the thoracic ganglia above the sixth. They descend obliquely by the sides of the bodies of the thoracic vertebræ, along the posterior mediastinum, and unite into a single nerve, which passes through the corresponding crus of the diaphragm, and joins the semi-lunar ganglion of the abdomen, sending also branches to the renal and supra-renal plexuses.

b. The *lesser splanchnic* nerve is commonly formed by branches from the tenth and eleventh ganglia. It passes through the crus of the diaphragm to the cœliac plexus, and occasionally to the renal plexus.*

c. The *smallest splanchnic* nerve comes from the twelfth ganglion, passes through the crus of the diaphragm, and terminates in the lower part of the cœliac and renal plexuses. (This is not represented in the diagram.)

FIG. 75. — DIAGRAM OF THE THORACIC PORTION OF THE SYMPATHETIC.

Intercostal Muscles. — The intercostal muscles fill in the intervals between the ribs and are arranged in each interval in two layers, an external and an internal, which cross each other like the letter X. The *external intercostals*, eleven on each side, run obliquely from behind forwards, like the external oblique muscle of the abdomen. They connect the contiguous borders of the ribs, passing from the outer lip of the rib above to the upper border of the rib below; they extend from the tubercles of the ribs behind to the costal cartilages in front, and are continued forwards to the sternum as a thin membrane. The *internal* run from before backwards like the internal oblique, and pass from the inner lip of the groove in the rib above and from the costal cartilage, and are inserted into the upper border of the rib below. Observe that a few fibres of the inner layer pass over one or even two ribs, chiefly near the angles (especially of the lower ribs), and terminate upon a rib lower down.†

* In a few instances we have traced a minute filament from one of the ganglia into the body of a vertebra. According to Cruveilhier each vertebra receives one.

† These irregular muscular bundles are called the *subcostal* or *infracostal muscles.*

Neither of tnese layers of intercostal muscles extends all the way between the sternum and the spine; the outer layer, beginning at the spine, ceases at the cartilages of the ribs; the inner commencing at the sternum, ceases at the angles of the ribs.

The intercostal muscles present an intermixture of tendinous and fleshy fibres; and they are covered inside and outside the chest by a glistening fascia, to give greater protection to the intercostal spaces.

The external intercostal muscles elevate the ribs, and are therefore muscles of inspiration. The internal intercostal muscles depress the ribs, and are therefore muscles of expiration.

Intercostal Arteries. — There are *ten* intercostal arteries on each side which lie between the internal and external intercostal muscles. The *two upper* arteries are derived from the superior intercostal branch of the subclavian; the remaining *eight* are furnished by the thoracic aorta; and since this vessel lies rather on the left side of the spine, the right intercostal arteries are longer than the left ten. The tenth runs along the lower border of the last rib and should be called the subcostal artery. The upper intercostal arteries from the aorta ascend obliquely to reach their intercostal spaces; the lower run more transversely. They are given off from the back of the descending aorta, and as they pass outwards across the bodies of the vertebræ they are covered by the pleura and the sympathetic nerves; the right, in addition, pass behind the œsophagus, thoracic duct, and the vena azygos major; the left behind the left superior intercostal vein and the vena azygos minor. Having reached the intercostal space, each artery divides into an *anterior* and a *posterior* branch. The *anterior* branch in direction and size appears to be the continuation of the common trunk. At first it runs *along the middle of the intercostal space*, lying upon the external intercostal muscle, and separated from the cavity of the chest by the pleura and intercostal fascia. Here, therefore, it is liable to be injured by a wound in the back. But near the angle of the rib it passes between the intercostal muscles, and occupies the groove in the lower border of the rib above. Here it gives off a small branch, the *collateral intercostal*, which runs for some distance along the upper border of the rib below. After supplying the muscles, the main trunk anastomoses with the anterior intercostal branch of the internal mammary artery. In some cases this branch is as large as the intercostal itself,

and situated so as to be directly exposed to injury in the operation of tapping the chest.

In its course along the intercostal space, each artery sends branches to the intercostal muscles and the ribs. About midway between the sternum and the spine, each gives off a small branch, which accompanies the lateral cutaneous branch of the intercostal nerve. The continued trunk, gradually decreasing in size, becomes very small towards the anterior part of the space, and is placed more in the middle of it. Those of the true intercostal spaces inosculate with branches of the internal mammary and thoracic branches of the axillary; those of the false run between the layers of the abdominal muscles, and anastomose with the epigastric and lumbar arteries.

The *posterior* or *dorsal* branch passes backwards between the transverse processes of the vertebræ, on the inner side of the anterior costo-transverse ligament, and is distributed to the muscles and skin of the back. Each sends an artery through the intervertebral foramen to the spinal cord and its membranes.

On the right side the intercostal veins terminate in the vena azygos major; on the left, the seven or eight lower terminate in the vena azygos minor, the remainder in the left superior intercostal vein.

The usual relation which the intercostal vessels and nerve bear to each other in the intercostal space, is, that the *vein lies uppermost*, *the nerve lowest*, and *the artery between them.*

Thoracic Nerves. — The *thoracic nerves* are twelve in number, the first emerging between the first and second thoracic vertebræ, and do not form a plexus as in the cervical, lumbar, and sacral regions. Each thoracic nerve (like all the spinal nerves) arises from the spinal cord by two roots, an anterior or motor, and a posterior or sensory. The sensory root has a ganglion upon it. The two roots unite in the intervertebral foramen and form a *compound* nerve. After passing through the foramen, it is connected by two filaments with the sympathetic nerve, and then divides into an *anterior* and a *posterior* branch. The *posterior* or *dorsal* branches pass backwards between the transverse processes of the thoracic vertebræ and divide into internal and external branches; the *internal* branches pass between the multifidus spinæ and semispinalis dorsi, pierce the rhomboidei and trapezius muscles; the six upper branches become cutaneous at the spinus processes of the vertebræ; the six lower supply only the multifidus spinæ, not giving off any

cutaneous filaments; the *external* branches pass through the longissimus dorsi and supply this muscle, the ilio-costalis and their continuations and the levatores costarum; the six lower branches, in addition, distribute cutaneous filaments to the skin. These branches will be described more fully later on in the dissection of the back.

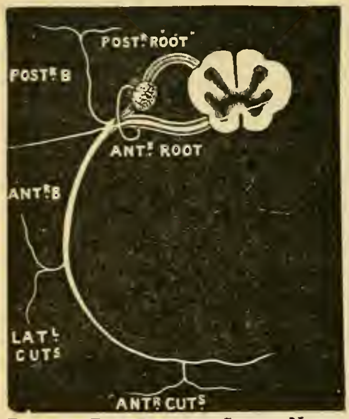


FIG. 76.—DIAGRAM OF A SPINAL NERVE.

Intercostal Nerves.—The *intercostal nerves* are the *anterior* divisions of the thoracic nerves, and are twelve in number. Each nerve receives a filament from the sympathetic, and then proceeds between the intercostal muscles in company with, and immediately below, the corresponding artery. Midway between the spine and sternum, they give off *lateral cutaneous branches*, which supply the skin over the scapula and the thorax. The intercostal nerves terminate in front in the *anterior cutaneous nerves.* In the anterior part of the intercostal space the nerves lie in the substance of the internal intercostal muscles, and at the costal cartilages get to the inner side of the muscles, passing between them and the pleura.

The intercostal nerves are divided into two sets: the six upper are called the pectoral intercostals, because they supply the structures of the pectoral region; the six lower, the abdominal intercostals, because they supply the chest and abdominal walls.

The *upper* or *pectoral intercostal nerves* pass between the external and internal intercostal muscles, run forwards in the substance of the latter muscle, and at the sternal end of the intercostal spaces pierce the internal intercostal muscles and the pectoralis major, to be ultimately distributed to the skin of the chest. The upper intercostal nerves supply the levatores costarum, serratus posticus superior, the intercostals, and the triangularis sterni.

The *lower* or *abdominal intercostal nerves* pass like the upper nerves between the intercostal muscles as far forwards as the costal cartilages. They pass behind these, and then run between the transversalis and internal oblique, as far as the outer border of the rectus. Piercing the sheath of the muscle, they supply

it, and subsequently end as the anterior cutaneous nerves of the abdomen. They supply the intercostal muscles, the serratus posticus inferior, and the abdominal parietal muscles.

Notice that the first thoracic nerve ascends nearly perpendicularly over the neck of the first rib to form part of the brachial plexus. This nerve, however, gives off a small branch, the first intercostal nerve, to supply the first intercostal space. This, as a rule, has no lateral cutaneous branch.

Intercostal lymphatic glands. — These are situated near the heads of the ribs; there are some between the layers of the intercostal muscles. They are of small size, and their efferent vessels go into the thoracic duct. Some of the upper ones on the right side pass into the right lymphatic duct. We have seen these intercostal glands enlarged and diseased in phthisis.

Bronchial and Œsophageal Arteries. — Small *bronchial arteries*, arising on the right side most frequently from the first aortic intercostal (third intercostal) artery, and on the left from the thoracic aorta, accompany the bronchial tube on its posterior aspect into the substance of the lung.* Their distribution and office will be considered with the anatomy of the lung. *Œsophageal arteries*, four or five in number, proceed from the front of the thoracic aorta to ramify on the œsophagus, where they inosculate above with the œsophageal branches of the inferior thyroid, and below with the œsophageal branches of the coronaria ventriculi and phrenic arteries. Small *posterior mediastinal arteries* are given off from the posterior part of the aorta, and supply the lymphatic glands and tissues of the posterior mediastinum.

Having finished the posterior mediastinum, replace the lung, and turn your attention once more to the great vessels at the root of the heart.

Pulmonary Artery. — This vessel is about two inches (*5 cm.*) in length, and conveys the venous blood from the heart to the lungs. It proceeds from the upper part of the base of the right ventricle, and passes upwards and backwards along the left side of the aorta to the concavity of the arch of the aorta, where it divides into two branches, a right and a left, one for each lung. At its origin it has on each side an auricular appendix and a coronary artery, and lies in front of the root of the aorta. The

* On the left side there are usually two bronchial arteries — a superior, arising from the highest part of the thoracic aorta, and an inferior, arising about an inch (*2.5 cm.*) lower down.

pulmonary artery and the aorta are surrounded for two inches (*5 cm.*) by a common sheath of pericardium. The right branch, the larger and longer, passes horizontally below the arch of the aorta, behind the ascending aorta and the superior vena cava, to the root of its lung; the left is easily followed to its lung by removing the layer of pericardium investing it, when it will be found to pass horizontally in front of the descending aorta and the left bronchus to the root of the left lung.

Search should be made for a short fibrous cord which connects the commencement of the left pulmonary artery with the concavity of the arch of the aorta. This cord is the remains of the *ductus arteriosus*, a canal which in fœtal life conveyed blood from the pulmonary artery to the aorta.

Draw towards the left side the first part of the arch of the aorta, and dissect the pericardium from the great vessels at the base of the heart. Thus a good view will be obtained of the trachea and its bifurcation into the two bronchi. Below the division of the trachea the right pulmonary artery is seen passing in front of the right bronchus. The superior vena cava and aorta are seen in front of, and nearly at right angles to, the right pulmonary artery. The vena azygos major is seen arching over the right bronchus and terminating in the vena cava superior, just before this vein pierces the pericardium. Notice, especially, a number of lymphatic glands called *bronchial*, at the angle of bifurcation of the trachea. The situation of these glands in the midst of so many tubes explains the variety of symptoms which may be produced by their enlargement.

Nerves of the Heart and Cardiac Plexuses. — The nerves of the heart come from the pneumogastric and its recurrent branch, and the three cervical ganglia of the sympathetic. The pneumogastric gives off (generally) two or more filaments (cardiac), which proceed from the main trunk in the neck, or from its recurrent branch. The sympathetic sends three (cardiac) filaments: one from the upper cervical ganglion, a second from the middle, and a third from the lower; and they are called, respectively, the upper, middle, and lower cardiac nerves of the sympathetic.

The minute and delicate nerves from these several sources on each side pass downwards to the base of the heart. They vary very much in their precise relations to the great vessels upon which they run; but, speaking generally, it may be said that the nerves on the right side run chiefly behind the arch of the aorta; those on the left, in front of it. Eventually they form, by their mutual subdivisions

and interlacement, an intricate network of nerves, termed, according to their position, the superficial and the deep cardiac plexus.

The *superficial* and *smaller cardiac plexus* lies in the concavity of the arch of the aorta in front of the right pulmonary artery. It is closely connected with the deep plexus. It receives the upper cardiac branch of the left sympathetic, the lower cervical cardiac branch from the left pneumogastric, and filaments from the deep plexus. In it is usually found a small ganglion, *ganglion of Wrisberg*, placed beneath the arch of the aorta, on the right side of the ductus arteriosus. This plexus distributes branches to the anterior coronary and the anterior pulmonary plexuses.

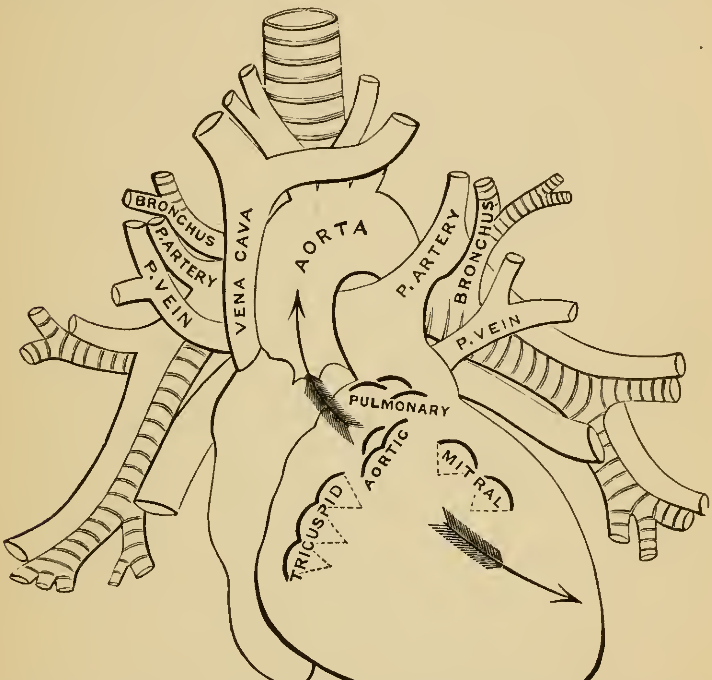


FIG. 77. — DIAGRAM SHOWING THE CONSTITUENTS OF THE ROOT OF EACH LUNG, AND THEIR RELATIVE POSITION; ALSO THE POSITION OF THE VALVES OF THE HEART. THE ARROWS INDICATE THE DIRECTIONS IN WHICH AORTIC AND MITRAL MURMURS ARE PROPAGATED.

The *deeper* and *larger cardiac plexus* is situated behind the arch of the aorta in front of the bifurcation of the trachea and immediately above the right pulmonary artery. To see it the pericardial covering of the aorta must be carefully removed and the vessel hooked forwards and to the left. This plexus is formed by all the cardiac branches of the right and left sympathetic ganglia, and by the cardiac branches of the pneumogastric and recurrent laryngeal nerves, except the left superior cardiac branch of the sympathetic and the left cervical cardiac branch of the pneumogastric, both of which pass to the superficial cardiac plexus. The branches from the *right* side of this plexus descend chiefly in front of the pulmonary artery and pass to the anterior pulmonary plexus and to the anterior coronary plexus; a few branches which pass behind the pulmonary artery are dis-

tributed to the right auricle and to the posterior coronary plexus. The branches from the *left* side of the plexus go to the left auricle, the anterior pulmonary plexus, but chiefly to the posterior coronary plexus.

From the cardiac plexuses, as a common centre, the nerves pass off to the heart, forming plexuses around the coronary arteries. Thus, the *anterior coronary plexus* (derived chiefly from the superficial cardiac) accompanies the anterior coronary artery. The *posterior coronary plexus* (derived chiefly from the left side of the deep cardiac) runs with the posterior coronary artery. The two plexuses communicate at the apex of the heart, and in the ventricular septum.

It is not an easy matter to trace the nerves into the substance of the heart. For this purpose a horse's heart is the best, and previous maceration in water is desirable. The nerves in the substance of the heart are peculiar in this respect; that they present minute ganglia in their course, which are presumed to preside over the rhythmical contractions of the heart.

Constituents of the Root of Each Lung. — Draw aside the margin of the right lung; divide the superior vena cava above the vena azygos, and turn down the lower part. Remove the layer of pericardium which covers the pulmonary veins, and the constituent parts of the root of the right lung will be exposed. It is composed of the pulmonary artery, the pulmonary veins, bronchus, bronchial vessels, anterior and posterior pulmonary plexuses, and some lymphatics. The following is the disposition of the large vessels forming the root of the lung. In front are the two pulmonary veins; behind the veins are the subdivisions of the pulmonary artery; behind the artery are the divisions of the bronchus. From above downwards they are disposed thus: On the right side we find — 1st, the bronchus; 2d, the artery; 3d, the veins. On the left we find — 1st, the artery; 2d, the bronchus; 3d, the veins — as shown in Fig. 77.

DISSECTION OF THE HEART.

Position.—The heart is conical in form, and more or less convex on its external aspect, with the exception of that portion lying on the tendinous centre of the diaphragm, which is flattened. It is situated obliquely in the thorax between the two lungs, and is completely surrounded by the pericardium. It extends from the fifth to the eighth thoracic vertebra, with its base directed upwards, backwards, and to the right, its apex downwards, forwards, and to the left, where during life it beats in the fifth intercostal space, two inches (*5 cm.*) below the nipple and an inch (*2.5 cm*) to its sternal side. The position which the heart bears to the thoracic walls has been already described (p.

188); it varies, however, in different subjects, and as a rule is higher in the dead body than in the living, owing to the shrinking of the lungs.

The anterior surface of the heart is convex and looks upwards and forwards; the posterior surface is flattened and rests upon the diaphragm: the former is chiefly formed by the right ventricle, the latter by the left ventricle. The right border is sharp (*margo acutus*); while the left border is thick and rounded (*margo obtusus*).

Size and Weight.—The size of the heart is dependent upon so many conditions, that the following measurements must be received with more or less limitation. An average heart will measure, in its transverse direction at the base, three and a half inches (*8.7 cm.*); in its length, about five inches (*12.5 cm.*); in its thickness, two and a half inches (*6.2 cm.*). The weight is from ten to twelve ounces (*283 to 336.6 grm.*) in the male, and from eight to ten (*264 to 283 grm.*) in the female; but much depends upon the size and condition of the body generally. As a rule, the heart gradually increases in length, breadth, and thickness from childhood to old age.

Notice two longitudinal grooves (*sulci*) on the front and back surfaces of the heart, which extend from the base of the ventricles to the apex, and which indicate the septum between the two ventricles; the anterior groove lies nearer to the left side, the posterior to the right side of the heart.

A circular groove, nearer the base, marks the separation between the auricles and ventricles. In the circular and longitudinal furrows, surrounded by more or less fat, run the coronary vessels, the nerves, and the lymphatics.

The heart is a double hollow muscular organ; that is, it is composed of two hearts, a right and a left, separated by a septum, and not communicating with each other except during uterine, and rarely in adult, life. Each half consists of two cavities, an *auricle* and a *ventricle*, which communicate by a wide orifice, the *auriculo-ventricular* opening. The right half of the heart propels venous blood to the lungs, and is called the *pulmonary;* the left propels arterial blood from the lungs throughout the body, and is called the *systemic.* These two hearts are not placed apart, because important advantages result from their union. By being enclosed in a single bag they occupy less room in the chest; and the action of their corresponding cavities being precisely synchronous, their fibres, mutually intermixing, contribute to their mutual support.

The cavities of the heart should now be examined in the order in which the blood circulates through them.

Right Auricle. — This is situated at the right side of the base of the heart, and forms a quadrangular cavity, the *atrium* or *sinus venosus*, between the two venæ cavæ, from which it receives the blood. From its front a small pouch projects towards the left, and overlaps the root of the aorta; this part is termed the *appendix auriculæ*, and resembles a dog's ear in shape.

Make a crucial incision over the anterior surface of the auricle, extending one prong into the appendix. The interior is lined by a polished membrane called the *endocardium*, and is everywhere smooth except in the appendix, where the muscular fibres are collected into bundles, called, from their resemblance to the teeth of a comb, *musculi pectinati*. They radiate from the auricle to the edge of the auriculo-ventricular opening.

The following objects are seen on opening the auricle: —

Superior or cephal vena cava.	Eustachian valve.
Inferior or caudal vena cava.	Coronary valve.
Coronary sinus.	Annulus ovalis.
Auriculo-ventricular opening.	Fossa ovalis.
Foramina Thebesii.	Tubercle of Lower.

Musculi pectinati.

Examine carefully the openings of the two *venæ cavæ:* they are not directly opposite to each other; the *superior cava* opens into the auricle on a plane rather in front, and a little to the left, of the inferior, so that its orifice is opposite to the auriculo-ventricular opening. The *inferior cava*, after passing through the tendinous centre of the diaphragm, makes a slight curve to the left before it opens into the lowest part of the auricle; its direction is upwards and inwards, so that the stream of blood is directed towards the auricular septum. The orifice of each vena cava is nearly circular, and surrounded by circular muscular fibres continuous with those of the auricle.

The posterior wall of the auricle is formed by the partition between the auricles, the *septum auricularum*. Upon this septum, above, and to the left of the orifice of the vena cava inferior, is an oval depression (*fossa ovalis*), bounded by a prominent border (*annulus ovalis*). This depression indicates the remains of the opening (*foramen ovale*) through which the blood in fœtal life passed from the right into the left auricle. After birth this opening closes; but if the closure is imperfect, the stream of

dark blood in the right auricle mixes with the florid blood in the left, and occasions what is called *cyanosis*. A valvular communication, however, not infrequently exists between the auricles in this situation which is not attended with indications of this disease.

A more or less noticeable fold of the lining membrane, the *Eustachian valve*, may be seen projecting from the front margin of the vena cava inferior to the front border of the fossa ovalis. It is placed between the inferior vena cava and the lower margin of the annulus ovalis. Curved in shape, it passes forwards and ends in two cornua ; of which, one is attached to the annulus ovalis, the other is lost on the wall of the auricle. It consists of a reduplication of the endocardium and contains some muscular tissue. It is the remnant of a valve, which was of con-

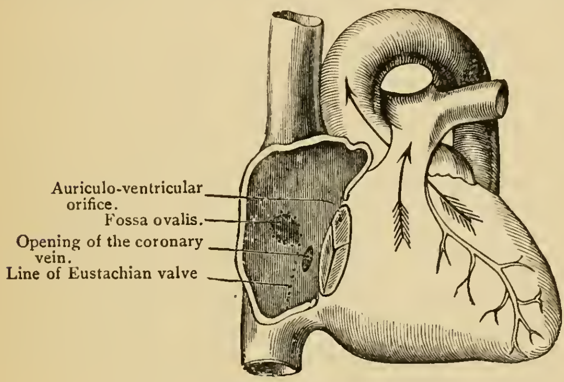


FIG. 78.— DIAGRAM OF THE INTERIOR OF THE RIGHT AURICLE.

siderable size in fœtal life, and served to direct the current of blood from the vena cava inferior, through the foramen ovale, into the left auricle.

To the left of the Eustachian valve, that is, between its remains and the auriculo-ventricular opening, is the orifice of the *coronary sinus*. The sinus is about an inch (2.5 *cm.*) in length and receives the great cardiac vein, the posterior cardiac vein, and the oblique vein (of Marshall), and will nearly admit the end of the little finger. It is surrounded by muscular fibres, and is guarded by a semicircular fold of the endocardium, called the *valve of Thebesius*,* to prevent regurgitation of the blood during the auricular contraction.

* This valve is occasionally double.

Here and there upon the posterior wall of the auricle may be observed minute openings for the small veins of the heart (*venae minimæ cordis*), called *foramina Thebesii*; some being the orifices of small veins returning blood from the substance of the heart; others being simple depressions in the muscular tissue. There is usually one larger than the others on the septal wall below the superior caval opening called *vena Galeni*. To the left, and rather in front of the orifice of the vena cava inferior, is the *auriculo-ventricular* opening, guarded by the tricuspid valve. It is oval in form, and will admit the passage of three fingers. Lastly, between the orifices of the superior and inferior venæ cavæ is a rounded elevation, the *tubercle of Lower* * (not seen in the diagram), which is supposed to direct the current of blood, in fœtal life, from the superior cava to the auriculo-ventricular opening.

The *musculi pectinati* are parallel muscular elevations running across the inner surface of the auricular appendix, and to a slight extent also of the sinus venosus.

Right Ventricle.† — This forms the right border and about two-thirds of the front surface of the heart. Observe that the wall of the ventricle is much thicker than that of the auricle. The cavity of the ventricle is conical, with base upwards and to the right. Its inner wall is convex, and is formed by the septum ventriculorum. The upper and front part presents a smooth passage, the *infundibulum* or *conus arteriosus*, which leads to the opening of the pulmonary artery. It is situated to the left and in front of the auriculo-ventricular opening, and about three-fourths of an inch (*18 mm.*) higher.

The following objects are seen in the right ventricle: —

Columnæ carneæ.	Auriculo-ventricular opening.
Chordæ tendineæ.	Pulmonary opening —

guarded by the tricuspid and semilunar valves.

From its walls project bands of muscular fibres, *columnæ carneæ*, of various length and thickness, which cross each other in every direction; this muscular network is generally filled with coagulated blood. Of these columnæ carneæ there are three

* Most distinct in quadrupeds.

† The ventricle can best be opened by a V incision made by introducing the scissors, and cutting parallel with the anterior ventricular septum into the pulmonary artery; then completing the V by cutting parallel with the postium ventricular septem up to, *but not through*, the auriculo-ventricular septum. — A. H.

kinds: one stands out in relief from the ventricle; another is attached to the ventricle by its extremities only, the intermediate portion being free; a third, and by far the most important set, called *musculi papillares*, is fixed by one extremity to the wall of the ventricle, while the other extremity gives attachment to the fine tendinous cords, *chordæ tendineæ*, which regulate the action of the tricuspid valve. The number of these musculi papillares is equal to the number of the chief segments of the valve; hence there are three in the right, and two in the left ventricle. Of those in the right ventricle, one is attached to the septum.

There are two openings in the right ventricle. One, the *auriculo-ventricular*, through which the blood passes from the auricle, is oval in form and placed at the base of the ventricle. It is surrounded by a ring of fibrous tissue, to which is attached the tricuspid valve.

Tricuspid Valve. — This is situated at the right auriculo-ventricular opening, and consists of three triangular flaps. Like all the valves of the heart, it is formed by a fold of the lining membrane (*endocardium*) of the heart, strengthened by fibrous tissue, in which a few muscular fibres may be demonstrated. The bases of the valves are continuous with one another, so that they form a membranous ring between the auricle and ventricle, while the segments project into the cavity of the right ventricle. Of its three flaps, the largest or anterior is so placed, that, when not in action, it partially covers the orifice of the pulmonary artery; another, the internal, corresponds with the inferior wall of the ventricle; the third, or posterior, rests upon the septum ventriculorum.

Observe the arrangement of the tendinous cords which regulate the action of the valve. First, they are all attached to the ventricular surface of the valve. Secondly, the tendinous cords proceeding from a given capillary muscle are attached to the adjacent halves of two of the flaps; consequently, when the ventricle contracts, and the papillary muscle also, the adjacent borders of the flaps will be approximated. Thirdly, to insure the strength of every part of the valve the tendinous cords are inserted at three different points of it in straight lines; accordingly, they are divisible into three sets. Those of the first, which are three or four in number, are attached to the base of the valve; those of the second, from four to six, proceed to the middle of its ventricular surface; those of the third, which are

the smallest and most numerous, are attached to its free margin.*

Pulmonary or Semilunar Valves. — These are three semicircular membranous folds, like watch-pockets, situated at the orifice of the pulmonary artery. They are attached by their convex borders to the root of the artery ; their free edges look upwards, and present a festooned border, in the centre of which is a small cartilaginous body, called the *nodulus* or *corpus Arantii.* The use of these bodies is plain. Since the valves are semilu-

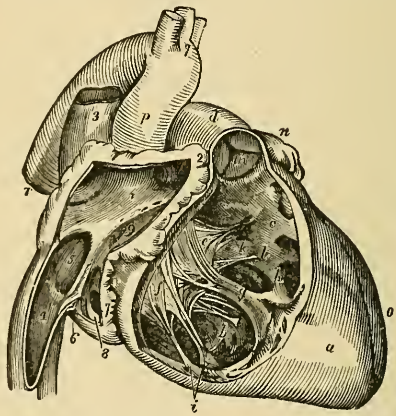


Fig. 79. — Anatomy of the Heart. — Right Side.

1. Cavity of right auricle. 2. Appendix auriculæ; in its cavity are seen the musculi pectinati. 3. Superior vena cava, opening into the upper part of the right auricle. 4. Inferior vena cava. 5. Fossa ovalis ; the prominent ridge surrounding it is the annulus ovalis. 6. Eustachian valve. 7. Opening of the coronary vein. 8. Coronary valve. 9. Entrance of the auriculo-ventricular opening. Between the figures 1 and 9, two or three foramina Thebesii are seen. *a.* Right ventricle. *b, c.* Cavity of right ventricle, on the walls of which columnæ carneæ are seen; *c* is placed in the channel leading upwards to the pulmonary artery, *d.* *e. f.* Tricuspid valve; *e* is placed in the anterior flap, *f* on the right flap. *g.* Long columna carnea, to the apex of which the anterior and right flaps are connected by chordæ tendineæ. *h.* The "long moderator band." *i.* The two columnæ carneæ of the right flap. *k.* Attachment by chordæ tendineæ of the left limb of the anterior flap. *l, l.* Chordæ tendineæ of the more fixed portion of the valve. *m.* Valve of the pulmonary artery. *n.* Apex of left appendix auriculæ. *o.* Left ventricle. *p.* Ascending aorta. *q.* Its transverse portion with the three arterial trunks which arise from the arch. *r.* Descending aorta.

* The best mode of showing the action of the valve is to introduce a glass tube into the pulmonary artery, and then to pour water through it into the ventricle until the cavity is quite distended. By gently squeezing the ventricle in the hand, so as artificially to imitate its natural contraction, the tricuspid valve will flap back like a flood-gate, and close the auriculo-ventricular opening. In this way one can understand how, when the ventricle contracts, the blood catches the margin of the valve, and by its pressure gives it the proper distention and figure requisite to block up the aperture into the auricle. It is obvious that the tendinous cords will prevent the valve from flapping back into the auricle; and this purpose is assisted by the papillary muscles, which nicely adjust the degree of tension of the cords at a time when they would otherwise be too much slackened by the contraction of the ventricle.

nar, when they fall together they would not exactly close the artery ; there would be a space of a triangular form left between them in the centre, just as there is when we put the thumb, fore, and middle fingers together. This space is filled up by these nodules, so that the closure becomes complete.

The valves, two anterior and one posterior, are composed of folds of the *endocardium*, or lining membrane of the heart. Between the folds is a thin layer of fibrous tissue, which is prolonged from the fibrous ring at the orifice of the artery. This layer of fibrous tissue, however, reaches the free edge of the

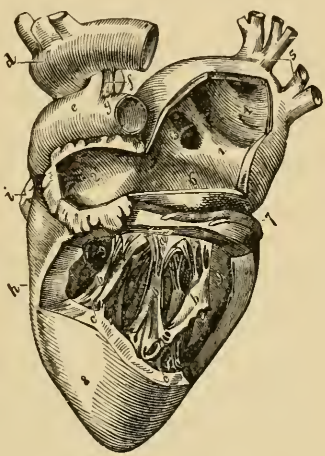


FIG. 80.—ANATOMY OF THE HEART.—LEFT SIDE.

1. Cavity of left auricle. 2. Cavity of the appendix auriculæ, near the apex of which are seen musculi pectinati. 3. Opening of the two right pulmonary veins. 4. The sinus into which the left pulmonary veins open. 5. Left pulmonary veins. 6. Auriculo-ventricular opening. 7. Coronary vein, lying in the auriculo-ventricular groove. 8. Left ventricle. 9, 9. Cavity of the left ventricle; the figures rest on the septum ventriculorum. *a*. Mitral valve; its flaps are connected by chordæ tendineæ to *b*, *b*, *b*. Columnæ carneæ. *c*, *c*. Fixed columnæ carneæ, forming part of the internal surface of the ventricle. *d*. Arch of the aorta, from the summit of which the three trunks (arterial) are seen. *e*. Pulmonary artery. *f*. Obliterated ductus arteriosus. *g*. Left pulmonary artery. *h*. Right ventricle. *i*. Point of the appendix of right auricle.

valve at three points only: namely, at the centre, or corpus Arantii, and at each extremity. Between these points it stops short, and leaves a crescent-shaped portion of the valve, which is thinner than the rest, and consists of the endocardial membrane. This crescent-shaped portion, called the *lunula*, is not wholly without fibrous tissue ; a thin tendinous cord runs along its free edge, to give it additional strength to resist the pressure of the blood. Behind each of the valves the artery bulges and forms three slight dilations called the *sinuses of Valsalva*.

These, we shall presently see, are more marked at the orifice of the aorta.

The action of these valves is evident. During the contraction of the ventricle the valves lie against the side of the artery, and offer no impediment to the current of blood; during its dilatation the elasticity of the distended artery would force back the column of blood, but that the valves, being caught by the refluent blood, bag, and fall together so as to close the tube. The greater the pressure, the more complete is the closure. The coats of the artery are very elastic and yielding, while the valve, like the circumference to which it is attached, is quite unyielding; consequently, when the artery is distended by the impulse of the blood, its wall is removed from the contact of the free margin of the valves, and these are the more readily caught by the regurgitating motion of the blood. The force of the reflux is sustained by the tendinous part of the valves, and by the muscular wall of the ventricle (probably in a state of contraction). The valves are capable of sustaining a weight of sixty-three pounds before they give way. The thinner portions (*lunulæ*) become placed so as to lie side by side, each one with that of the adjacent valve. This may be demonstrated by filling the artery with water.

Left Auricle. — This is situated at the left side and posterior part of the base of the heart, and is somewhat smaller than the right auricle. It consists, like the right auricle, of a cavity — the *sinus venosus* — and the *auricular appendix*. It is quadrilateral, and receives the four pulmonary veins, two on either side, which return the oxygenated blood from the lungs. From its upper and left side, the *auricular appendix* projects towards the right, curling over the root of the pulmonary artery. The auricle should be opened by a horizontal incision along the ventricular border of the auricle, and another should be made upwards from the centre of the first incision.

The interior of the *atrium* is smooth and flat, but in the appendix there are numerous raised muscular bands, the musculi pectinati. The interior presents the following objects for examination: —

The orifices of the four pulmonary veins.
The auriculo-ventricular opening.
The musculi pectinati.

The openings of the pulmonary veins are seen in the posterior wall, two on the right side (sometimes three), and two on the

left side. They are not guarded by valves. Upon the septum between the auricles is a semilunar depression, indicating the remains of the foramen ovale. The *auriculo-ventricular opening*, situated at the lower and front part of the auricle, is smaller than that of the right side, and somewhat oval. Its long axis is nearly transverse, and, in the adult, will admit the passage of two fingers. The *musculi pectinati* are also smaller and fewer than in the right auricle.

Left Ventricle.* — This occupies the left border, and forms the apex of the heart. One-third of it only is seen on the anterior surface, the rest being on the posterior. To examine the interior, raise a triangular flap, with the apex below, from its front wall. Observe that its wall is about three times as thick as that of the right ventricle, and that this thickness gradually diminishes towards the apex. The interior of the left ventricle presents the following objects for examination: —

Auriculo-ventricular opening.	Auriculo-ventricular or mitral valves.
Aortic opening.	Semilunar valves.
Columnæ carneæ.	

These parts so closely resemble that of the right that there is no necessity to describe them in detail. The *auriculo-ventricular valve* consists of two flaps; hence its name, *mitral* or *bicuspid*. The larger of these flaps is placed between the aortic and auriculo-ventricular orifices. There are only two *musculi papillares:* one attached to the anterior, the other to the posterior wall of the ventricle. They are thicker, and their *chordæ tendineæ* stronger, than those of the right ventricle, but their arrangement is precisely similar. From the upper and back part of the ventricle a smooth passage leads to the orifice of the aorta. This orifice is placed in the groove between the two auricles, and somewhat in front and to the right side of the left auriculo-ventricular opening. The two orifices are close together, and only separated by the larger flap of the mitral valve. The aortic orifice is guarded by three semilunar valves, of which the arrangement, structure, and mode of action are similar to those of the pulmonary artery. Their framework is proportionally stronger, consistently with the greater strength of the left ventricle, and the greater impulse of the blood. In the *sinuses of Valsalva* are observed the orifices of the two

* Similar incision should be made as indicated for the right ventricle (p. 216). — A. H.

coronary arteries; the left arising from the sinus behind the left posterior segment; the right from behind the anterior segment.

Size of the Auriculo-ventricular and Arterial Openings. — The circumferences of the four orifices are as follows: that of the tricuspid orifice, 4.74 inches (*11.8 cm.*); that of the mitral, 4 inches (*10 cm.*); that of the pulmonary, 3.55 inches (*8.7 cm.*); and that of the aortic, 3.14 inches (*7.7 cm.*).*

Coronary Arteries. — The heart is supplied with blood by the two coronary arteries, a right or posterior, and a left or anterior. They are about the size of a crow's quill. Both arise from the aorta just above the free margins of the two semilunar valves, and thus always allow the passage of blood; both run in the furrows on the surface of the heart; both are accompanied by the cardiac nerves and by lymphatics.

The *anterior* or *left coronary* artery, the smaller of the two, arises from behind the left posterior valve of the aortic orifice. It appears between the pulmonary artery and the appendix of the left auricle, and then divides into two branches: one which seems the continuation of the main trunk and runs down the inter-ventricular furrow on the anterior surface of the heart to the apex; the other passes transversely to the left, in the left auriculo-ventricular groove to the back of the heart.

The *posterior* or *right coronary* artery arises from behind the anterior cusp of the aortic opening, and descends obliquely between the pulmonary artery and the appendix of the right auricle. It then turns to the right in the groove between the right ventricle and auricle to the back of the heart, where it divides into two branches; one of which descends in the posterior inter-ventricular furrow towards the apex of the heart; the other, which appears to be the continuation of the main trunk, runs in the left auriculo-ventricular groove. Besides these branches, the right coronary gives off a large branch which runs along the free border of the right ventricle.

Thus, the leading trunks of the coronary arteries run in the furrows of the heart, usually surrounded by fat. Their numerous branches supply the walls of the auricles and ventricles, and their terminations communicate with each other.

Coronary Veins and Sinus. — The vein which corresponds with the anterior coronary artery ascends in the anterior interventricular sulcus, and then curves round the left side of the heart in the left auriculo-ventricular groove, where it takes the name of the *great cardiac vein.* This vein soon dilates into a large trunk, the *coronary sinus*, which opens at the back of the right auricle below the Eustachian valve.

Another vein, known as the *posterior cardiac*, ascends along the posterior inter-ventricular groove, to open by valved orifices into the coronary sinus; while others,

* Dr. Peacock, *Croonian Lectures*, 1865.

the *anterior cardiac veins*, three or four in number, are seen running up on the anterior surface of the right ventricle to terminate directly in the right auricle.

The *venæ Thebesii* transmit the blood directly from the muscular structure into the right auricle by small apertures, the foramina Thebesii. The *coronary sinus* is about an inch (*2.5 cm.*) in length, and receives the great cardiac vein, the posterior cardiac vein, and the oblique vein of Marshall, placed on the posterior surface of the left auricle. Its orifice in the right auricle is guarded by a semilunar valve (*valve of Thebesius*) to prevent regurgitation of the blood. It is covered and more or less supported in its course by muscular fibres passing from one auricle to the other.

The *lymphatics* of the heart pass mainly into a trunk which runs in the anterior inter-ventricular groove, and then, passing into the glands between the aorta and trachea, open into the right lymphatic duct; other smaller lymphatics pass into the thoracic duct.

The *nerves* are derived from the cardiac plexuses, which have been already described, p. 210.

Fibrous Rings of the Heart. — What may be termed the fibrous skeleton of the heart consists of four rings, which surround, respectively, the four orifices at its base; namely, the two auriculo-ventricular, the aortic, and the pulmonary. These rings give attachment by their external circumference to the muscular fibres of the heart, and from their internal circumference send fibrous prolongations to form the framework of the several valves. The skeleton is strongest just in the triangular interspace between the aortic and the two auriculo-ventricular orifices (letter A in Fig. 81). In some animals, as in the ox and the elephant, there is here an irregularly triangular bone, known as the os cordis.

The relative position of these rings is best seen by removing the auricles and the great vessels at the base of the heart — leaving the several valves, and looking at them from above, as shown in the diagram. The pulmonary ring is on the highest level, and nearest to the sternum; below it, is the aortic ring lying between and in front of the auriculo-ventricular rings, which are on the lowest level.

Attachment of the Large Arteries to the Ventricles. — The fibrous rings at the arterial orifices present three festoons with their concavities directed upwards. These give attachment, above, to the middle coat of the artery; below, to the muscular fibres of the ventricles; and, internally, to the fibrous tissue of the valves. The vessels are also connected to the heart by the serous layer of the pericardium, and by a continuation of the lining membrane of the ventricle.

Epicardium. — This, the visceral layer of the pericardium, closely invests the external surface of the heart, and presents the usual appearances of a visceral serous membrane.

Endocardium. — This smooth membrane lining the cavities of the heart resembles the visceral layer of the pericardium, and is continuous with the inner coat of the blood-vessels. It may be

easily stripped off, and is thin and semi-transparent, thicker in the left than in the right cavities, thickest of all in the left auricle.

Arrangement of the Muscular Fibres of the Auricles. — The fibres of the auricles are distinct from those of the ventricles. They consist of a *superficial* layer common to both cavities, and a *deeper* layer proper to each. The *superficial* fibres run transversely across the auricles, and are most marked on the anterior surface; some pass into the inter-auricular septum. Of the *deeper* fibres, some are *annular* and surround the auricular appendages and the entrance of the great veins, upon which a few may be traced for a short distance; others, *looped*, run over the auricles, and are attached in front and behind to the auriculo-ventricular rings.

Arrangement of the Muscular Fibres of the Ventricles. — Speaking generally, it may be said that the right and left ventricles of the heart are two conical muscular sacs, enclosed in a third, which not only envelops them, but is reflected

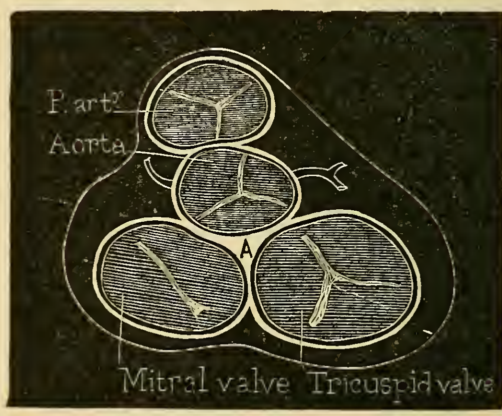


FIG. 81. — DIAGRAM OF THE RELATIVE POSITION OF THE VALVES OF THE HEART, SEEN FROM ABOVE.

A is placed on the triangular interval where the fibrous skeleton is the thickest.

into the interior of both, at their apices, so as to line their cavities. All the muscular fibres are attached by one end to the fibrous rings of the orifices, and, by the other end, after a more or less spiral course, they reach the rings again, either directly or through the medium of the chordæ tendineæ and valves.

The external or superficial fibres pass from the base, where they are attached to the auriculo-ventricular rings, to the apex. This layer is thin in front, but behind it is better marked, and here the fibres do not pass into the septum, but over it, while in front they pass over the anterior septum, only at the base and apex of the ventricle. The fibres run more or less spirally towards the apex, where they form a whorl and pass into the left ventricle, so as to form, in part the innermost vertical muscular layer, in part the fleshy columns of its cavity. The superficial anterior fibres pass backwards to the left, and form, behind, the posterior papillary muscle; and, on the other hand, the superficial fibres pass over the right side of the heart and constitute the anterior papillary muscle.

The remaining fibres of the left ventricle, which constitute its chief thickness, are attached to the fibrous rings at the base of the heart. They pass, more or less

obliquely, in the posterior and anterior walls, and entering the lower end of the septum pass in three different directions: *one set*, upwards in the septum to be attached to the fibrous tissue in the triangular interspace; a *second set* pass through the septum to form the posterior wall of the right ventricle and its posterior papillary muscle; while the *third set* take a transverse circular course in the left ventricle, some of its fibres being continuous with those of the right ventricle.

The fibres of the right ventricle are arranged on a plan similar to that of the left ventricle, of which it may be considered an appendage. The fibres, which correspond to those forming the chief thickness of the left ventricle, are similarly arranged into an interior, middle, and posterior set: the anterior pass backwards into the septum to reach the posterior wall of the left ventricle, and interlace in the septum with the posterior set, which pass forwards in the septum to the front wall of the left ventricle; the middle set come chiefly from the outer wall of the right ventricle, deep down at the lower part of the septum, and then ascend to be attached to the fibro-cartilage. Besides these there are more or less numerous annular fibres encircling the right ventricle.*

Thickness of the Cavities. — The average thickness of the right auricle is about $\frac{1}{12}$ of an inch (*2 mm.*); that of the left $\frac{1}{8}$ of an inch (*3 mm.*). The average thickness of the right ventricle at its thickest part — *i.e.*, the base — is about $\frac{1}{6}$ of an inch (*4 mm.*); that of the left ventricle at its thickest part — *i.e.*, the middle — is about half an inch (*12.5 mm.*). In the female the average is less.

Peculiarities of the Fœtal Circulation. — The heart and the circulation of the fœtus differ from that of the adult in the following points: —

1. The *Eustachian valve* is well developed as a crescentic fold which guides the current of blood from the inferior vena cava through the right auricle into the foramen ovale.

2. The *foramen ovale* is widely open up to the fourth month, after which a septum grows up from the lower border of the left side, so that at the sixth month the blood can only pass in the onward direction into the left auricle.

3. The *right* and *left pulmonary arteries* are very small and ill developed, so as to admit very little blood to the lungs.

4. The *ductus arteriosus*, from the commencement of the left pulmonary artery to the aorta, is widely open.

5. The *hypogastric* or *umbilical arteries*, branches of the anterior division of the internal iliac, emerge through the umbilicus and pass to the placenta, so that the impure blood may be oxygenated.

* There are other accounts given of the arrangements of the muscular structure of the heart, and that given by Pettigrew is one which is adopted by many of the best anatomists. For further information on this subject consult Pettigrew, *Philosoph. Transactions*, 1864; Dr. Sibson, *Medical Anatomy*, 1869; Winckler, *Müller's Archiv*, 1865; Quain's *Anatomy*, vol. ii. p. 495, 1882.

6. The *umbilical vein* returns the pure blood partly to the liver, and partly through the —

7. *Ductus venosus* into the inferior vena cava.

8. The *right* and *left ventricles* are of equal thickness, because they have equal work to perform.

FŒTAL CIRCULATION.

Circulation of the Blood in the Fœtus. — Arterial blood is brought from the placenta by the umbilical vein (Fig. 82), and enters at the umbilicus, whence it passes to the under surface of the liver. Here it gives off some branches to the left lobe, and others to the lobulus Spigelii and lobulus quadratus, which eventually return their blood into the inferior vena cava. At the transverse fissure it divides

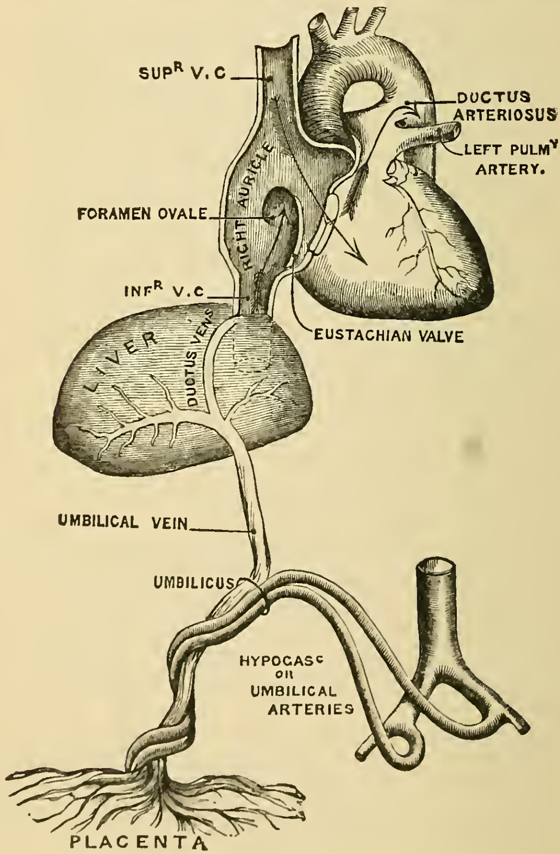


FIG. 82. — SCHEME OF THE FŒTAL CIRCULATION.

into two branches — one, the smaller, termed the *ductus venosus*, passes straight to enter into the inferior vena cava, having previously joined the left hepatic vein; the other, or right division, joins the vena portæ, and, after ramifying in the right lobe of the liver, returns its blood through the hepatic veins into the inferior vena cava.

From the inferior vena cava, which thus receives its blood from three sources, the blood enters the right auricle, and the stream (directed by the Eustachian valve) flows through the foramen ovale into the left auricle, where it becomes mingled with a little blood, which is returned from the pulmonary veins. From the 'eft auricle it runs through the left auriculo-ventricular opening into the left ventricle, and thence through the aorta into the great vessels of the head and upper extremities (only a small quantity passing into the descending thoracic aorta), which are thus supplied by almost pure blood. From the head and upper limbs the blood returns (impure) through the superior vena cava into the right auricle, whence, mixed with a small quantity derived from the inferio cava, it passes into the right ventricle. From the right ventricle the blood passes through the pulmonary artery and the ductus arteriosus into the commencement of the descending aorta, only a very small quantity of it being distributed to the lungs; the lungs are in the fœtus almost solid organs, and the blood distributed to them is returned by the pulmonary veins into the left auricle. The blood which passes into the descending aorta, through the ductus arteriosus, is mingled with the small amount coming through the arch, and is then conveyed through the abdominal aorta into the iliac arteries; part is transmitted through the umbilical arteries (branches of the internal iliac arteries) to the placenta to become re-oxygenated; part passes into the lower extremities through the external iliac and femoral arteries.

Changes in the Circulation at Birth. — The following changes take place in the circulation after birth: —

1. The *umbilicus vein* becomes obliterated from the second to the fifth day after birth, and subsequently forms the round ligament of the liver.
2. The *ductus venosus* also becomes closed about the same period, and may be traced as a thickened cord in the fissure of the ductus venosus.
3. The *foramen ovale* becomes closed from the sixth to the tenth day; but not infrequently a small, indirect valvular communication may be found forming a communication between the two auricles.
4. The *ductus arteriosus* contracts immediately after birth, and becomes closed from the sixth to the tenth day. It eventually forms a fibrous cord connecting the left pulmonary artery with the aorta, the left recurrent laryngeal nerve winding round its left border.*
5. The *pulmonary arteries* enlarge and convey venous blood to the lungs. These organs during fœtal life receive only a small quantity of blood from these arteries.
6. The *hypogastric arteries* become obliterated on the fourth or fifth day after birth.

STRUCTURE OF THE LUNGS.

The lungs are very vascular, spongy organs in which the blood is oxygenated by exposure to atmospheric air. Their situation and shape have been described (p. 177). We must now

* The initial cause of the closure of the ductus arteriosus has been attributed to the contraction of the muscular fibres reflected to the fibrous pericardium from the diaphragm, the upper portion of the pericardium being held firmly through the attachment of the cervical fascia to it and the first rib, thereby preventing the descent of the central tendon of the diaphragm. The muscular fibres act as tensors of the pericardium, which embrace the duct in question. (A. H.)

examine the trachea, the common air-passage to both lungs, and then trace this tube downwards to its bifurcation into the two bronchi, which, with their minute subdivisions, form the main structure of the lungs.

Trachea. — This is a partly cartilaginous, partly membranous tube, and is situated in the middle line. It extends from the cricoid cartilage, *i.e.*, opposite the upper border of the sixth cervical vertebra, to the third thoracic vertebra, where it divides into two tubes, the right and left bronchus — one for each lung. Its length is from four and a half to five inches (*11.2 cm. to 12.5 cm.*), and its width from two-thirds to five-sixths of an inch (*16 to 20 mm.*); but these measurements vary according to the age and sex of the patient, and the capacity of the lungs. The trachea is surrounded by a quantity of loose connective tissue, so as to allow of its free mobility. It is kept permanently open by a series of incomplete cartilaginous rings, from sixteen to twenty in number, which extend round the anterior two-thirds of its circumference. These rings are deficient at the posterior part of the tube, where it is completed by a fibro-muscular membrane. This deficiency allows the trachea to enlarge or diminish its calibre; and for this purpose the membranous part of the tube is provided with unstriped muscular fibres which can approximate the ends of the rings.

The relations of the trachea to the surrounding parts should be considered, first, in the neck, and then within the thorax.

In the neck, it has, in *front* of it, the isthmus of the thyroid body, the sterno-hyoid and sterno-thyroid muscles, the inferior thyroid veins, two layers of the deep cervical fascia, the arteria thyroidea ima, if present, and (at the root of the neck) the innominate and left common carotid arteries. *Laterally*, it is in relation with the lobes of the thyroid body, the common carotid arteries, the recurrent laryngeal nerves, and the inferior thyroid arteries. *Behind* it is the œsophagus, inclining slightly to the left.

In the chest the trachea is contained in the superior mediastinum, and has, in *front* of it, the manubrium sterni, the origins of the sterno-hyoid and thyroid muscles, the left brachio-cephalic vein, the first parts of the innominate and left common carotid arteries, the transverse portion of the arch of the aorta, and the deep cardiac plexus. On the *right* side are the pleura and right pneumogastric nerve; on the *left*, the pleura, the left carotid, the left pneumogastric, cardiac, and recurrent laryngeal nerves.

Bronchi, Right and Left. — The two *bronchi* differ in length, direction, and diameter. The *right*, wider but shorter than the left, is about an inch (*2.5 cm.*) long, and passes more horizontally to the root of its lung, on a level with the fourth thoracic vertebra. It is larger in all its diameters than the left; hence, foreign bodies which have accidentally dropped into the trachea are more likely to be carried into the right bronchus by the current of the air. The vena azygos major arches over the right bronchus to terminate in the superior vena cava. The *left* is

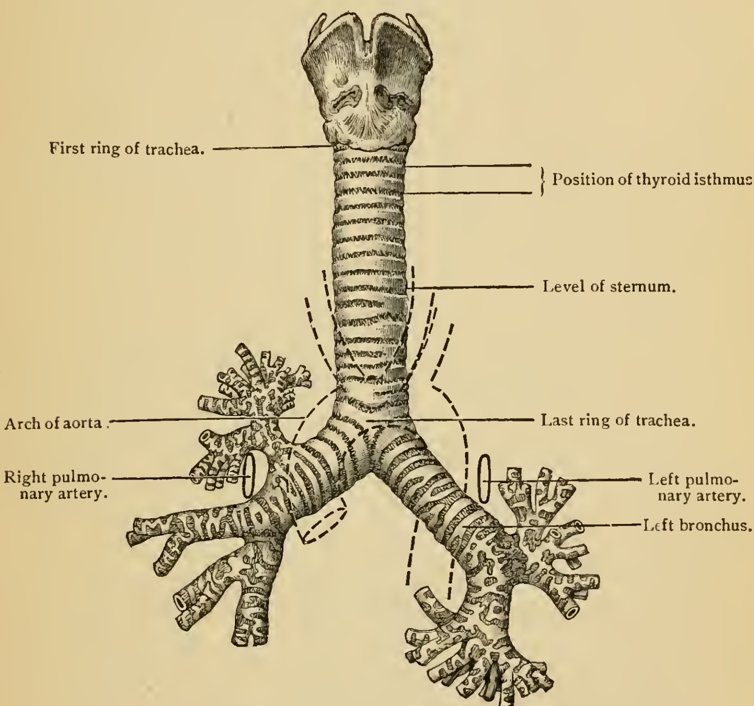


Fig. 83.—Anterior View of the Larynx, with the Trachea and Bronchi.

about two inches (*5 cm.*) in length, and, descending more obliquely to its lung than the right, enters it on a level with the fifth thoracic vertebra. The left bronchus passes under the arch of the aorta, in front of the œsophagus and the thoracic duct, and subsequently crosses in front of the descending aorta.

The *cartilages* of the trachea vary in number from sixteen to

twenty, of the right bronchus from six to eight, and of the left from nine to twelve. Those of the trachea form about two-thirds of a circle, somewhat like a horseshoe in shape, are about one-sixth of an inch (*4 mm.*) in their vertical direction, and one-twenty-fifth (*1 mm.*) in thickness, and thicker in the middle than at the upper and lower borders. The cartilages are connected and covered on their outer and inner surfaces by a tough membrane, consisting of connective and elastic tissues with some muscular fibres (*tracheal muscle*). This membrane is attached above to the circumference of the cricoid cartilage, and is continued through the whole extent of the trachea and bronchial tubes. Posteriorly, where the cartilages are deficient, it completes the integrity of the air tube. In this tissue, which is of a pale reddish color, is a layer of unstriped muscular fibres, arranged in a transverse and a longitudinal direction.

The first cartilage is the broadest, and is frequently divided at one end; the last cartilage is placed at the bifurcation of the trachea, and is shaped like the letter V; its angle projects into the centre of the main tube, and its sides belong one to each bronchus.

Muscular Fibres. — This thin stratum of unstriped muscular fibres consists of two layers, and is brought into view when the fibrous membrane and tracheal glands have been removed. The longitudinal fibres are the more external, and are attached by minute tendons to the extremities of the cartilages; the transverse fibres (*trachealis muscle*) extend transversely between the posterior free ends of the cartilages. By their contraction they approximate the ends of the cartilages and diminish the calibre of the trachea.

Elastic Tissue. — This lines the whole tube, but is most abundant at the posterior or membranous part of the trachea, and its fibres run in a longitudinal direction. It is this layer which raises the mucous membrane into folds, and its elasticity admits of the elongation and the recoil of the tube.

Tracheal Glands. — Upon the outer surface of the fibrous layer of the trachea are a number of small mucous glands, most numerous on the posterior part of the tube. They are compound racemose glands lined with columnar epithelium, and their excretory ducts pierce the fibrous and muscular layers, and terminate on the free surface of the mucous membrane. In health their secretion is clear, and just sufficient to lubricate the air-passages. In bronchitis they are the sources of the abundant viscid expectoration.

Mucous Membrane. — The *mucous membrane* lining the air-passages is a continuation of that of the larynx. Its color in the

natural state is nearly white, but in catarrhal affections it becomes bright red in consequence of the accumulation of blood in the capillary vessels. It is continued into the ultimate air-cells, where it becomes thinner and more transparent. In its deeper layer is found a considerable amount of elastic tissue, in its

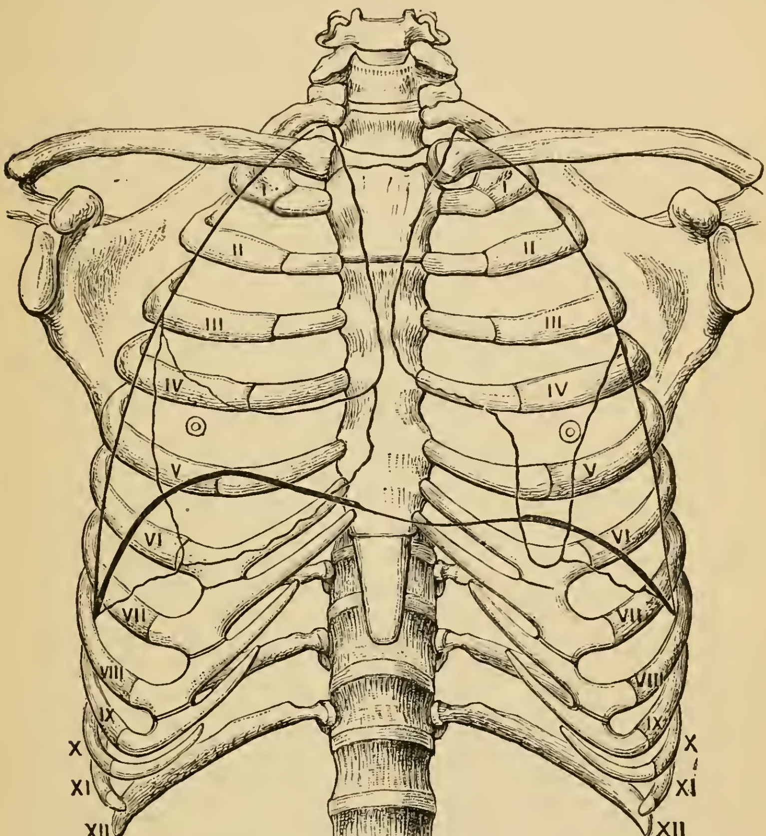


FIG. 84.—ANTERIOR VIEW OF THE THORAX, WITH OUTLINES OF THE DIAPHRAGM AND LUNGS.

superficial layer a quantity of lymphoid tissue. Its surface is lined with a layer of columnar ciliated epithelial cells. The vibratile movement of the cilia is directed in such a way as to favor the expectoration of the mucus. The ciliated epithelium lining the mucous membrane ceases at the commencement of the air-cells, where it is replaced by the squamous variety.

At the root of the lung each bronchus divides into two branches, an upper and a lower, corresponding to the lobes of the lung; on the right side the lower branch sends a small division to the third lobe of the lung. The tubes diverge through the lung, and divide into branches, successively smaller and smaller, until they lead to the air-cells. These ramifications do not communicate with each other; hence, when a bronchial tube is obstructed, all supply of air is cut off from those cells to which it leads.

The several tissues — cartilaginous, fibrous, muscular, mucous, and glandular — which compose the air-passages, are not present in equal proportions throughout all their ramifications, but each is placed in greater or less amount where it is required. The cartilaginous rings necessary to keep the larger tubes permanently open become, in the smaller tubes, fewer and less regular in form. As the subdivisions of the tubes multiply, the cartilages consist of small pieces placed here and there; they become less and less firm, and finally disappear when the tube is reduced to $\frac{1}{25}$ of an inch (*1 mm.*) in diameter. The smallest air-passages are entirely membranous, being formed of fibrous, elastic, and muscular tissues.

The Lungs. — The lungs are two in number, and occupy the lateral cavities of the chest. Each is conical in shape, its apex extending into the neck, the base resting on the upper or convex surface of the diaphragm. The lung presents for examination — an apex, a base, two surfaces, and two borders.

The *apex* extends upwards about an inch (*2.5 cm.*) above the clavicle, and is generally marked by a slight groove for the subclavian artery. The *base* is concave, and slopes downwards at its posterior part. Its *outer surface*, in contact with the chest wall, is smooth and convex, and is deeper behind than in front. Its *inner surface* is concave, and hollowed out to accommodate the heart and its large vessels. Its *anterior border* is sharp, and overlaps the large vessels and the pericardium. The *posterior border* is rounded, and rests in the broad groove on the side of the bodies of the thoracic vertebræ. On the inner concave surface, a little above the middle and nearer the posterior than the anterior border, is the *root*, where the large vessels and bronchi pass to and from the lungs.

Each lung is traversed on its external surface by an oblique fissure which passes deeply into its interior. It extends from the upper part of the posterior border, downwards and forwards

to the anterior border, and on the right side there is a second fissure passing, forwards and upwards from the oblique fissure, to the middle of the anterior margin. The left lung presents a deep notch in the anterior border in which the pericardium is seen as far as the apex of the heart.

The posterior border of the lung is indicated by a line drawn from the level of the spinous process of the seventh cervical vertebra down on either side of the spine over the costo-vertebral joints as low as the spinous process of the tenth thoracic vertebra. The trachea bifurcates opposite the fourth thoracic vertebra, and from this point the two bronchi are directed outward, the right one almost horizontally, the left one with an inclination downward and slightly forward. The lower border of the lung is marked with a slightly curved line, having its convexity downward, drawn from the sixth costo-chondral articulation to the tenth thoracic spine. This curved line will be intersected by vertical lines drawn from the nipple, from the mid-axilla, from the inferior scapular angle; the first at the sixth rib, the second at the eighth rib, and the third at the tenth rib. The position of the great fissure in the right lung may be indicated by a line drawn from the second thoracic vertebra around the chest wall to the sixth costo-chondral articulation. The smaller or secondary fissure in the right lung is indicated by a line drawn from the point where the midaxillary line crosses the third or fourth rib downward and forward to the fourth chondro-sternal circulation. — A. H.

Contractibility of the Lung. — When an opening is made into the chest, the lung, which was in contact with the ribs, immediately recedes from them, and, provided there be no adhesions, gradually contracts. If the lungs be artificially inflated, either in or out of the chest, we observe that they spontaneously expel a part of the air. This disposition to contract, in the living and the dead lung, is due to the elastic tissue in the bronchial tubes and the air-cells; but more especially to a layer of delicate elastic tissue on the surface of the lung, which has been described by some anatomists as a distinct coat, under the name of the second or inner layer of the pleura.*

Color. — The lungs are of a livid red or violet color; they often present a mixture of tints, giving them a marble-like appearance. This is not the natural color of the organ, since it is produced in the act of dying. It depends upon the stagnation of the venous blood, which the right ventricle still propels

* In some animals, the seal especially, the elasticity of this tissue is very strongly marked.

into the lungs, though respiration is failing. The tint varies in particular situations in proportion to the amount of blood, and is always deepest at the back of the lung. But the color of the proper tissue of the lung, apart from the blood which it contains, is pale and light gray. This color is seldom seen except in the lungs of infants who have never breathed, or after death from profuse hæmorrhage.

Upon or near the surface of the lungs, numerous dark spots are observed which do not depend upon the blood, since they are seen in the palest lungs. They vary in number and size, and increase with age. The source of these discolorations is not exactly known; but they are probably deposits of minute particles of carbonaceous matter which have been inhaled with the air.

The lungs are composed of cartilaginous and membranous tubes, of which the successive subdivisions convey the air into closely-packed minute cells, called the *air-vesicles;* of the ramifications of the pulmonary artery and veins; of the bronchial vessels concerned in their nutrition; of lymphatics and nerves. These component parts are united by connective tissue, and covered externally by pleura. The part at which they respectively pass in and out is called the *root of the lung.*

The lungs are the lightest organs in the body, and float in water, their specific gravity varying from .345 to .746. When entirely deprived of air, they sink. This is observed in certain pathological conditions; *e.g.*, when one lung is compressed by effusion into the chest, or rendered solid by inflammation.

The surface of the lung is closely invested by a thin, transparent layer of *serous membrane,* immediately beneath which is a fine areolar tissue, called *subserous*, which is very soft and elastic so as to allow of the free expansion of the organ. This tissue sends inwards prolongations, called *interlobular,* which map out the lungs into a number of angular spaces of various sizes termed *lobules;* those on the surface, indicated by faint white lines, are larger than those in the interior of the lung. Each lobule is a lung in miniature, and consists of a small bronchial tube and its termination in dilated extremities, called *infundibula,* of ramifications of the pulmonary vessels, lymphatics, and nerves, and, lastly, of the bronchial vessels. The cells of the interlobular tissue have no communication with the air-vesicles, unless the latter be ruptured by excessive straining, and then this connective tissue becomes inflated with air, and is

called *interlobular emphysema*. When infiltrated with serum it constitutes *œdema* of the lung.

Each bronchial tube divides and subdivides into smaller and smaller divergent tubes, until each has reached a reduced size of about $\frac{1}{25}$ of an inch (*1 mm.*); it then enters a pulmonary lobule, when it is termed a *lobular bronchial tube*, and presents on its walls numerous dilatations, called air-cells or *alveoli*, which vary from $\frac{1}{50}$ to $\frac{1}{70}$ of an inch (*or about* $\frac{1}{2}$ *to* $\frac{1}{3}$ *mm.*) in diameter (Fig. 85). Thus reduced in size, the walls of the tubes no longer present traces of cartilaginous tissue, but are composed of a delicate elastic membrane upon which the capillaries ramify in a very minute network.* Each tube finally terminates in an enlarged irregular passage — *alveolar passage* — from which proceed on all sides numerous blind dilatations, named *infundibula*.

FIG. 85. — ULTIMATE AIR-CELLS OF THE LUNG (FROM KOLLIKER). MAGNIFIED TWENTY-FIVE TIMES.

The smaller bronchial tubes are encircled by more or less complete rings of cartilage; but as the tubes lessen in calibre, the rings become less perfect; so that when the tubes are reduced to $\frac{1}{25}$ of an inch (*1 mm.*) in diameter, the rings entirely disappear. The continuation of the air-tubes consists simply of fibrous tissue which becomes gradually thinner, so that in the smallest tubes they are reduced to simply membranous tubes, and are continued on as irregular passages — *intercellular passages* † — which are studded with numerous small saccules, termed *air-cells* or *alveoli*.

The *air-cells* are small, shallow, polyhedral depressions, $\frac{1}{100}$ of an inch (*25 μ*) in diameter, separated by thin partitions or septa which communicate freely with the intercellular passages, but not with each other.

The *mucous membrane* which invests the divisions of the bronchi as far as the intercellular passages is lined with epithelium of the columnar ciliated variety. At this situation the

* In phthisis the expectoration contains some of the *débris* of this elastic framework of the air-vesicles; it can be seen under the microscope, and is a test of the character of the sputa.

† Rainey, *Med. Chir. Trans.*, vol. xxviii. 1845.

character of the epithelium changes to that of a squamous kind, consisting of a single layer of flat polygonal nucleated cells.

The structure of the air-cells differs in some important features from that of the smaller bronchial tubes; the muscular tissue disappears, the elastic tissue is no longer arranged in bundles, but becomes frayed out and intermingled with the connective tissue.

Pulmonary Vessels. — The *pulmonary artery* conveying venous blood to the lungs divides and subdivides with the bronchial tubes, and terminates in a fine dense capillary plexus on the walls of the intercellular passages and air-cells, beneath the epithelium. These plexuses — the *pulmonary capillaries* — form a single layer of capillaries which is so close that the interstices are even narrower than the blood-vessels. The plexus which ramifies over the air-cell does not communicate with the plexus covering another air-cell. The blood and air are not in actual contact. Nothing, however, intervenes but the wall of the cell and the capillary vessels, which are such delicate structures that they oppose no obstacle to the free interchange of gases by which the blood is purified. This purification is effected by the taking in of oxygen, and the elimination of carbonic acid and watery vapor. The most complete purification takes place in the single layer of capillaries between the folds of membrane projecting into the cell; for in this situation both sides of these vessels are exposed to the action of the air. The blood, circulating in steady streams through this capillary plexus, returns through the pulmonary veins. These, at first extremely minute, gradually coalesce into larger and larger branches which anastomose very freely, and accompany the arteries. They finally emerge from the root of the lung by two large trunks which carry the oxygenated blood to the left auricle of the heart. The pulmonary veins are not provided with valves.

Bronchial Arteries. — These small arteries, two or more in number, are the nutrient vessels of the lungs. The right arises either from the first aortic intercostal, or, conjointly with the left bronchial, from the thoracic aorta. The left, usually two in number, come from the thoracic aorta. They enter the lung behind the divisions of the bronchi, which they accompany. The bronchial vessels are distributed in various ways; some of their branches supply the coats of the air-passages, the large blood-vessels, and the lymphatic glands; others the interlobular tissue; a few reach the surface of the lung and ramify beneath

the pleura. The right *bronchial veins* terminate in the vena azygos, the left in the superior intercostal vein.

The *nerves* of the lung are derived from the pneumogastric and the sympathetic. They enter with the bronchial tubes, forming a plexus in front and behind them, *anterior* and *posterior pulmonary plexus*, in which are found minute ganglia.

The *lymphatics* of the lungs consist of a superficial and deep set; some commence in the lymphatic capillaries in the interlobular tissue, and thence pass to the surface, forming a network which communicates with the subpleural lymphatic plexus; others take their origin in the mucous membrane of the bronchial tubes; and all eventually enter the bronchial glands. Of these the larger are situated about the bronchi near the root of the lung, particularly under the bifurcation of the trachea.

DISSECTION OF THE PHARYNX.

Dissection.— To obtain a view of the pharynx cut through the trachea, the œsophagus, the large vessels, and nerves of the neck, a short distance above the first rib, and then separate them from the prevertebral muscles which lie immediately in front of the bodies of the cervical vertebræ, and to which they are but loosely connected. Saw out a V-shaped piece from the temporal and occipital bones, the prongs of the V pointing towards the anterior condyloid foramina. Introduce a fine jig-saw and aim for the insertion of the rectus capitis anticus muscle on the basilar process of the occipital bone passing behind the jugular foramina. When this is accomplished the student will find that the pharynx and larynx are left attached to the anterior half of the section, the spinal column and the prevertebral muscles to the posterior half. Tow should then be introduced through the mouth and œsophagus to distend the walls of the pharynx.

One side of the pharynx should be dissected to show the constrictor muscles, the other should be reserved for the vessels and nerves in immediate relation with the pharynx.

General Description of Pharynx.— The pharynx (φάρυγξ, *the throat*,) is the common passage for the air and the food. Into it the posterior nares (2) (choanæ), the isthmus of the fauces from the mouth, eustachian tubes (2), larynx, and œsophagus open. It is a funnel-shaped muscular bag, about four and a half inches (*11.3 cm.*) in length, and broader in its transverse

than in its antero-posterior diameter. Its broadest portion is situated opposite the os hyoides, and it then gradually tapers as far as the cricoid cartilage, where it is continuous with the œsophagus, which is its narrowest portion. Its *upper part* is attached to the basilar process of the occipital bone and the petrous portions of the temporal bones; *behind*, it is loosely connected by deep cervical fascia with the prevertebral muscles; * in *front*, it is attached to the internal pterygoid plates and hamular processes of the sphenoid, to the pterygo-mandibular ligaments, the mandible, the tongue, the hyoid bone, and the stylo-hyoid ligaments, and to the thyroid and cricoid cartilages; *laterally*, it is loosely connected to the styloid muscles, and it has in close relation with it the common and internal carotid arteries, the glosso-pharyngeal, pneumogastric, spinal accessory, hypoglossal, and sympathetic nerves; the internal pterygoid, tensor palati, and stylo-pharyngeus muscles; the lingual and ascending pharyngeal arteries, the superior laryngeal and external laryngeal nerves, the ascending palatine artery, and the internal jugular vein. Its dimensions are not equal throughout. Its breadth at the upper part is equal to that of the posterior openings of the nose (*choanæ*); here it is only required to conyey air, but it becomes much wider in the situation where it transmits the food — that is, at the back of the mouth; thence it gradually contracts to the œsophagus. The pharynx, therefore, may be compared to a funnel communicating in front by wide apertures with the nose, the mouth, and the larynx; while the œsophagus represents the tube leading from its lower end. The upper part of the funnel forms a cul-de-sac at the basilar process of the occipital bone. At this part there is, on each side, the opening of a narrow canal, called the Eustachian tube, through which air passes to the tympanum of the ear.†

Before the muscles of the pharynx can be examined, we must

* It is in this tissue (which never contains fat) that post-pharyngeal abscesses are seated.

† Observe that the pharynx conducts to the œsophagus by a gradual contraction of its channel. This transition, however, is in some cases sufficiently abrupt to detain a foreign body, such as a morsel of food more bulky than usual, at the top of the œsophagus. If such a substance become firmly impacted in this situation, one can readily understand that it will not only prevent the descent of food into the stomach, but that it may occasion, by its pressure on the trachea, alarming symptoms of suffocation. Supposing that the obstacle can neither be removed by the forceps, nor pushed into the stomach by the probang, it may then become necessary to extract it by making an incision into the œsophagus on the left side of the neck.

remove a layer of thin fascia, termed the *pharyngeal fascia.* It is the layer of deep cervical fascia behind the pharynx, and must not be confounded with the proper *pharyngeal aponeurosis,* which intervenes between its muscular and mucous walls.

At the back of the pharynx, near the base of the skull, are a few *lymphatic glands.* They sometimes enlarge, and form a perceptible tumor in the pharynx.

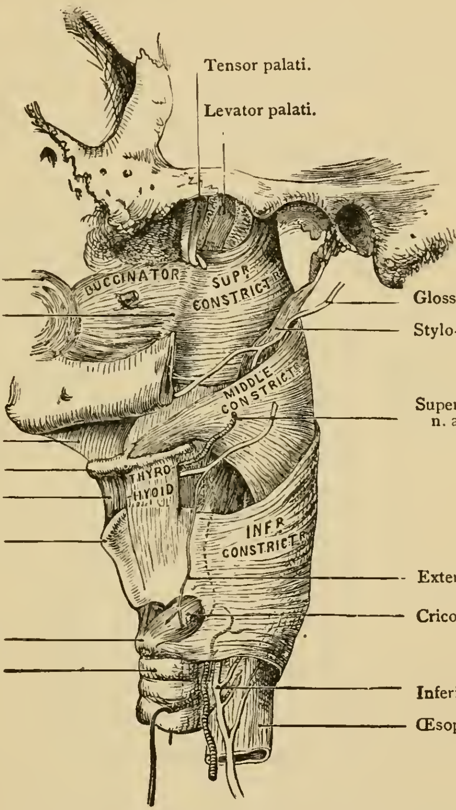


FIG. 86.—SIDE VIEW OF THE MUSCLES OF THE PHARYNX.

In removing the fascia from the pharyngeal muscles, notice that a number of veins ramify and communicate in all directions. They constitute the *pharyngeal venous plexus,* and terminate in the internal jugular vein.

Constrictor Muscles of the Pharynx. — They are three in

number and arranged so that they overlap each other, *i.e.*, the inferior overlaps the middle, and the middle the superior (Fig. 86). They have the same attachments on both sides of the body; and the fibres from the right and left meet together and are inserted in the mesial line, the insertion being marked by a white longitudinal line, called the *raphé.*

The *inferior constrictor*, the most superficial and thickest of the thin constrictors, *arises* from the side of the cricoid cartilage behind the crico-thyroid muscle, from the surface behind the oblique ridge and the lower cornu of the thyroid cartilage. Its fibres expand over the lower part of the pharynx. The superior fibres ascend; the middle run transversely; the inferior descend slightly, and are *inserted* into the posterior median raphé. The lower fibres are continuous with those of the œsophagus. Beneath its lower border the recurrent laryngeal nerve enters the larynx. Its *nerve-supply* is from the pharyngeal plexus, the external laryngeal, and the recurrent laryngeal nerves.

In order to completely expose the next muscle, the right half of the interior constrictor should be reflected from the middle line.

The *middle constrictor arises* from the upper edge of the greater cornu of the os hyoides, from its lesser cornu, and part of the stylohyoid ligament, and is *inserted* into the posterior median raphé. Its fibres take different directions, so that, with those of the opposite muscle, they form a lozenge. The lower angle of the lozenge is covered by the inferior constrictor; the upper angle ascends nearly to the basilar process of the occipital bone, and terminates upon the pharyngeal aponeurosis. The external surface of the muscle is covered at its origin by the hyo-glossus, from which it is separated by the lingual artery; while beneath it are the superior constrictor, the stylo-pharyngeus, and palato-pharyngeus muscles and the pharyngeal aponeurosis. Its *nerve* comes from the pharyngeal plexus.

Between the middle and inferior constrictors, the superior laryngeal artery and nerve perforate the thyro-hyoid membrane to supply the larynx.

The *superior constrictor* consists of pale muscular fibres, and *arises* from the hamular process of the sphenoid bone, and from the lower part of its internal pterygoid plate; from the tuberosity of the palate bone and the reflected tendon of the tensor palati; from the pterygo-mandibular ligament (which connects it with the buccinator); from the back part of the myloid

ridge of the mandible, and from the side of the tongue. The fibres pass backwards to the mesial raphé; some of them are *inserted* through the medium of the pharyngeal aponeurosis into the basilar process. Its *nerve* comes from the pharyngeal plexus.

The upper border of the superior constrictor presents, on either side, a free semilunar edge with its concavity upwards, so

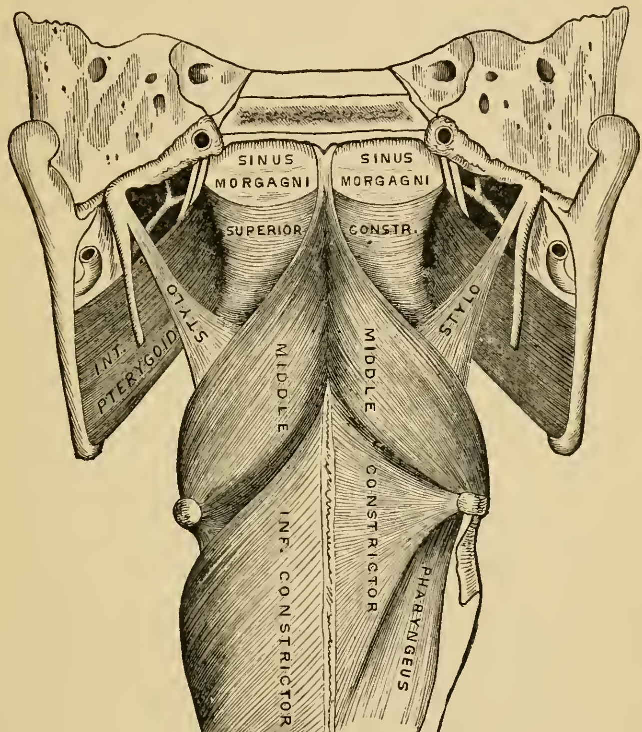


FIG. 87.—VIEW OF THE CONSTRICTOR MUSCLES FROM BEHIND.

that, between it and the base of the skull, a space is left in which the muscle is deficient (Fig. 87). Here the pharynx is strengthened and walled in by its own aponeurosis. The space is called the *sinus of Morgagni;* and in it, with a little dissection, we expose the muscles which raise and tighten the soft palate, *i.e.*, the levator palati and the tensor palati. The Eustachian tube opens into the pharynx just here. The fibres of the

stylo-pharyngeus pass in between the superior and middle constrictors, and expand upon the side of the pharynx; some of them mingle with those of the constrictors, so as to be able to lift up the pharynx in deglutition; but most of them are inserted into the superior and posterior margins of the thyroid cartilage.

Action of Pharyngeal Muscles. — The pharyngeal spine of the occipital bone being the fixed point, the muscles contract from above downward through the median raphé. The larynx being raised, and the tongue pressing upon the soft palate in its projection backwards, force the food into the embrace of the superior constrictor after it has passed the isthmus. As the superior constrictor arises on a higher plane than that of the food projected into it, there is exerted upon the bolus by this muscle pressure on three sides, as well as from above downwards. The middle and inferior constrictors exert lateral pressure upon the bolus of food. May not these muscles combined act as a sounding-board in the expression of sound? — A. H.

Pharyngeal Aponeurosis. — The *pharyngeal aponeurosis* intervenes between the muscles and the mucous membrane of the pharynx. It is attached to the basilar process of the occipital bone, and to the points of the petrous portions of the temporal bones. It maintains the strength and integrity of the pharynx at its upper part, where the muscular fibres are deficient; but it gradually diminishes in thickness as it descends, and is finally lost on the œsophagus. Notice the number of mucous glands upon this aponeurosis, especially near the base of the skull and the Eustachian tube. These glands sometimes enlarge and cause deafness from the pressure on the tube.

Openings into the Pharnyx. — Lay open the pharynx by a longitudinal incision in the middle line, up to the pharyngeal tubercle; then divide transversly, for a short distance, that part of the pharyngeal aponeurosis which is attached to the basilar process, so as the better to view the cavity of the pharynx. Observe the seven openings leading into it (Fig. 88): 1. The two posterior nares (*choanae*); below the nares is the soft palate, with the uvula. 2. On either side of them, near the lower turbinated bones, are the openings of the Eustachian tubes. 3. Below the soft palate is the communication with the mouth, called the isthmus faucium. On either side of this are two folds of mucous membrane, constituting the anterior and posterior half-arches of the palate; between them are the tonsils. Below the isthmus faucium is the epiglottis, which is connected to the

base of the tongue by three folds of mucous membrane. 4. Below the epiglottis is the aperture of the larynx. 5. Lastly, is the opening into the œsophagus.*

The pharynx consists of three coats, viz., muscular, fibrous, and mucous. The two former have been already described.

Mucous Membrane. — The *mucous membrane* is common to the entire tract of the respiratory passages and the alimentary canal. This membrane, however, presents varieties in the different parts of these channels, according as they are intended as passages for air or for food. The mucous membrane of the pharynx above the velum palati, being intended to transmit air only, is very delicate in its texture, and lined by columnar ciliated epithelium like the rest of the air-passages. But opposite the fauces, the mucous membrane resembles that of the mouth, and is provided with squamous epithelium. At the back of the larynx the membrane is corrugated into folds, to allow the expansion of the pharynx during the passage of the food.

The membrane is lubricated by a secretion from the numerous mucous glands which are situated in the submucous tissue throughout the whole extent of the pharynx, particularly in the neighborhod of the Eustachian tubes.†

Posterior Openings of the Nasal Fossæ. — These are two oval openings, each of which is about an inch (*2.5 cm.*) in the long, and half an inch (*13 mm.*) in the short diameter. They are bounded above by the body of the sphenoid bone, externally by its pterygoid plate, below by the horizontal portion of the palate bone; they are separated from each other by the vomer.

On removing the mucous membrane from the posterior part of the roof of the nose and the top of the pharynx, you will find beneath it much fibrous tissue. Hence polypi growing from these parts are, generally, of a fibrous nature.

Isthmus Faucium. — This name is given to the opening by which the mouth communicates with the pharynx. It is bounded above by the soft palate and uvula, below by the root of the tongue, and on either side by the arches of the palate, enclosing the tonsils between them.

* On reflecting the mucous membrane at the pharyngeal termination of the Eustachian tube, a thin pale muscle, the *salpingo-pharyngeus*, can be made out. It arises by a thin tendon from the Eustachian tube, and joins the palato-pharyngeus. It is lost among the fibres of the constrictor muscles.

† This aggregation of mucous glands is called the pharyngeal tonsil.

Soft Palate, or Velum Pendulum Palati. — This movable prolongation of the roof of the mouth is attached to the border of the hard palate, and laterally to the side of the pharynx anteriorly to posterior margin of the palate process of the palatine bone. Posteriorly it has a free edge, with a pendulous conical

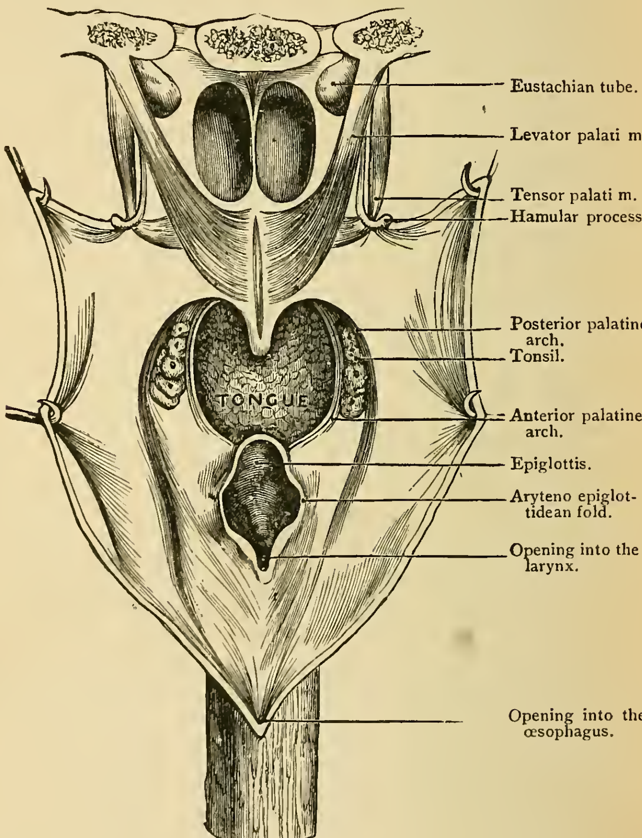


Fig. 88.—Diagrammatic View of the Pharynx laid open from behind.

projection in the centre, called the *uvula*. It constitutes an imperfect partition between the mouth and the posterior nares (*choanæ*). Its upper or nasal surface is convex, and continuous with the floor of the nose, its lower surface is concave, in adaptation to the back of the tongue, and is marked in the middle by a ridge or raphé, indicating its original formation by two lateral

halves. The soft palate, when at rest, hangs obliquely downwards and backwards; but in swallowing, it is raised to the horizontal position by the levatores palati, and is pushed up by the bolus of food and tongue, comes into apposition with the back of the pharynx, and thus prevents the food from passing through the nose.

On making a perpendicular section through the soft palate, you come first upon the oral mucous membrane; then you see that the great bulk of it is made up of *muciparous glands*, which lie thick on its under surface to lubricate the passage of the food. Above these glands is the thin layer of the palato-glossus, then the insertion of the tensor palati forming the broad aponeurosis of the palate; still higher, are the two portions of the palato-pharyngeus, separated by the fibres of the levator palati, the azygos uvulæ, and, lastly, the nasal mucous membrane. The soft palate is supplied with blood by the descending palatine branch of the internal maxillary, the ascending palatine branch of the facial, the ascending pharyngeal and the dorsales linguæ of the lingual artery. Its *nerves* are derived from the palatine branches of the maxillary division of the fifth and from the glosso-pharyngeal.

Uvula. — The uvula projects from the middle of the soft palate, and gives the free edge of it the appearance of a double arch. It contains a number of muciparous glands, and a small muscle, the *azygos uvulæ* which is double and not single as the name implies. Its length varies according to the state of its muscle. It occasionally becomes permanently elongated, and causes considerable irritation, a tickle in the throat, and harassing cough. When you have to remove a portion of it, cut off only the redundant mucous membrane.

Arches or Pillars of the Palate. — The *soft palate* is connected with the tongue and pharynx by two folds of mucous membrane on each side, enclosing muscular fibres. These are the *anterior* and *posterior arches* or *pillars* of the palate. The *anterior arch* describes a curve downwards and forwards, from the base of the uvula to the side of the tongue. It is well seen when the tongue is extruded. The *posterior arch*, commencing at the side of the uvula, curves downwards and backwards, along the free margin of the palate, and terminates on the side of the pharynx. The posterior arches, when the tongue is depressed, can be seen through the span of the anterior. The pillars of each side diverge from their origin, and in the triangular space

thus formed is situated the tonsil. The chief use of the arches of the palate is to assist in deglutition. The anterior, enclosing the *palato-glossi* muscles, contract so as to prevent the food from coming back into the mouth ; the posterior, enclosing the *palato-pharyngei*, contract like side curtains, and cö-operate in preventing the food from passing into the nose. In vomiting, food does sometimes escape through the nostrils, but one cannot wonder at this, considering the violence with which it is driven into the pharynx.

Muscles of the Soft Palate. — The muscles of the soft palate lie immediately beneath the mucous membrane. There are five pairs — namely, the levatores palati, the circumflexi or tensores palati, the palato-glossi, the palato-pharyngei, and the azygos uvulæ. This last pair is sometimes described as a single muscle. To clean the muscles, the soft palate should be made tense by means of hooks, as they are severally dissected.

Levator Palati. — This muscle *arises* from the under aspect of the apex of the petrous portion of the temporal bone, and from the under part of the cartilage of the Eustachian tube. It descends obliquely inwards, and then passes over the concave border of the superior constrictor into the pharynx, where its fibres spread out and are *inserted* along the upper surface of the soft palate below the azygos uvulæ, meeting those of its fellow in the middle line (Fig. 89). Its action is to raise the soft palate, so as to make it horizontal in deglutition and in speaking preventing the nasal twang. It is supplied by the descending palatine branch from the spheno-palatine ganglion.

Circumflexus or Tensor Palati. — This muscle is situated between the internal pterygoid m. and the internal pterygoid plate of the sphenoid bone. It *arises* by a flattened muscular belly from the scaphoid fossa, and from the spine of the sphenoid; from the outer surface and anterior margin of the cartilage of the Eustachian tube. Thence it descends perpendicularly, and ends in a tendon which winds round the hamular process, where there is a synovial bursa. Now changing its direction, the tendon passes horizontally inwards, and expands into a broad aponeurosis, which is *inserted* into the horizontal plate of the palate bone, and is also connected to its fellow of the opposite side. It gives strength to the soft palate. A synovial membrane facilitates the play of the tendon round the hamular process. Its *action* is to draw down and tighten the soft palate, and, owing to its insertion into the palate bone, also to keep the

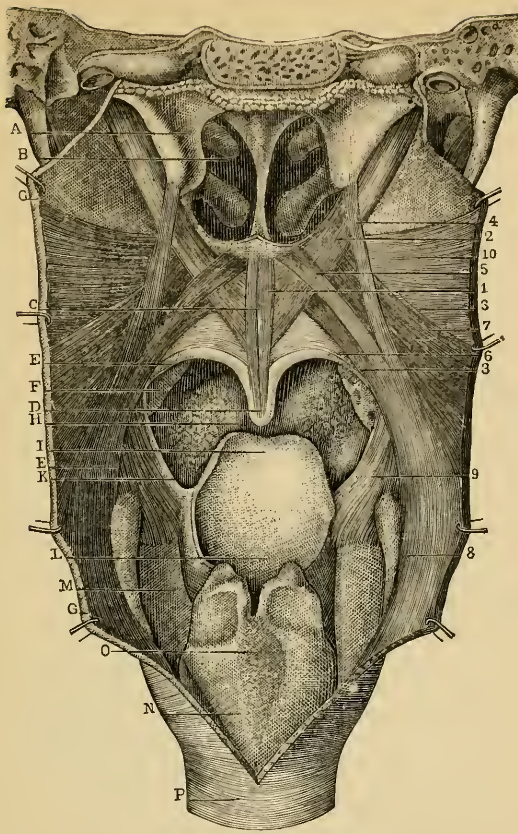


FIG. 89. — PHARYNX OPEN POSTERIORLY, SHOWING LARYNX, TONGUE, AND SOFT PALATE.

A. Cartilaginous expansion of the Eustachian tube. B. Posterior nasal openings. C. Soft palate. D. Uvula. E. Posterior pillar of the palate. F. Tonsil. G, G. Pharynx opened in median line. H. Base of the tongue. I. Epiglottis. K. Left glosso-epiglottidean fold. L. Superior opening of the larynx. M. Thyroid cartilage. N. Posterior surface of the larynx. O. Group of grape-like glands constantly found in these positions. P. Upper extremity of the œsophagus. 1. Azygos uvulæ muscle. 2. Levator palati muscle. 3, 3. Palato-pharyngeus muscle. 4. Salpingo-pharyngeus muscle. 5. Internal portion of the palato-pharyngeus muscle. 6. Fibres proceeding from the middle of the palate and ending in the palato-pharyngeus muscle. 7. Superior fibres of the palato-pharyngeus muscle going to interlace on the lateral and posterior surface of the pharynx with those of the opposite side. 8. Inferior fibres of the palato-pharyngeus muscle being inserted into the posterior margin of the thyroid cartilage near the base of the superior cornu and pharyngeal aponeurosis. 9. Anterior fibres of the stylo-pharyngeus muscle attached, 1st, to the lateral fold of the epiglottis; 2d, to the superior cornu of the thyroid cartilage at the base and superior margin. 10. Superior constrictor of the pharynx.

Eustachian tube open. Its *nerve* is derived from the otic ganglion, and enters the muscle on its inner aspect.

Azygos or Levator Uvulæ. — This consists of two thin bundles of parallel muscular fibres situated one on each side of

the middle line. It *arises* from the aponeurosis of the palate and descends along the uvula nearly down to its extremity. It receives its *nerve* from the descending palatine branch of the spheno-palatine ganglion.

Palato-glossus and Palato-pharyngeus. — These muscles are contained within the arches of the soft palate, and the mucous membrane must be removed in order to expose them. The *palato-glossus*, within the anterior arch, proceeds from the interior surface of the soft palate to the side of the tongue, and is lost in the stylo-glossus muscle. The *palato-pharyngeus*, within the posterior arch, *arises* from the posterior border of the soft palate by two origins, separated by the levator palati. As it descends its fibres spread out, and, passing along the side of the pharynx, blend with the fibres of the inferior constrictor and the stylo-pharyngeus. The *action* of the palato-glossus is to draw down the palate when the pharynx is fixed; the *palato-glossus* to elevate the sides of the tongue when the soft palate is fixed; both motions combined close this portion of the fauces, as is necessary in swallowing. Their separate action is called into play in speaking. The *action* of the palato-pharyngeus is to draw together the posterior pillars; to depress the palate when the pharynx is fixed; to elevate the pharynx when the palate is fixed. Both these muscles are *supplied* by the descending palatine branches of the spheno-palatine ganglion.

Tonsils. — The tonsils are two glandular bodies ½ of an inch (*13 mm.*) long, ⅓ of an inch (8 *mm.*) in width and thickness, situated at the entrance of the fauces, between the arches of the soft palate. They are rounded in shape, and their use is to lubricate the fauces during the passage of the food. On their inner surface are visible from twelve to fifteen orifices leading into crypts, which make the tonsil appear like the shell of an almond. Hence, as well as from their oval figure, they are called the *amygdalæ*. (Fig. 90.)

These openings lead into small follicles in the substance of the tonsil, lined by a mucous membrane. Their walls are thick, and around them is a layer of closed cells (like Peyer's glands) situated in the submucous tissue. The fluid secreted by these cells is viscid and transparent, in the healthy state; but it is apt to become white and opaque in inflammatory affections of the tonsils, and occasionally accumulates in these superficial depressions, giving rise to the deceptive appearance of a small ulcer, or a slough, or even a false membrane on the part.

The tonsil lies close to the inner side of the internal carotid artery. It is only separated from this vessel by the ascending pharyngeal artery, the superior constrictor, and the aponeurosis of the pharynx. Therefore, in removing a portion of the tonsil, or in opening an abscess near it, the point of the instrument should never be directed outwards, but *inwards* towards the mesial line.* The tonsil is supplied with blood by the tonsillar and palatine branches of the facial, and by the descending pala-

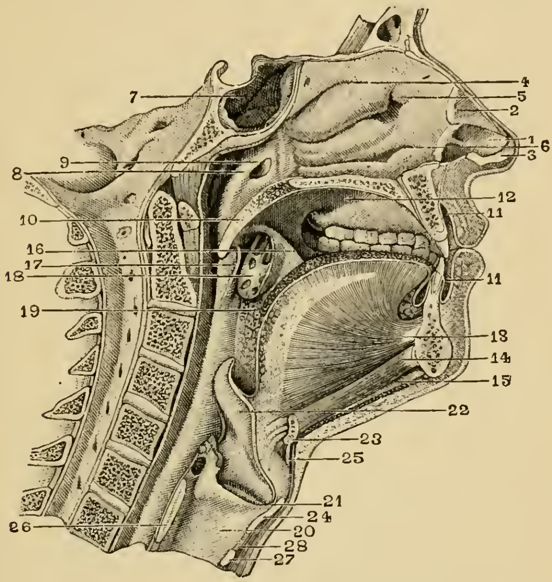


FIG. 90.—VERTICAL SECTION OF THE NASAL FOSSÆ AND MOUTH.

1. Left nares. 2. Lateral cartilage of the nose. 3. Portion of the internal alar cartilage forming the skeleton of the lower part. 4. Superior meatus. 5. Middle meatus. 6. Inferior meatus. 7. Sphenoidal sinuses. 8 External boundary of the posterior nares. 9. Internal elliptical opening of the Eustachian tube. 10. Soft palate. 11. Vestibule of the mouth. 12. Vault of palate. 13. Genio-glossus muscle. 14. Genio-hyoid muscle. 15. Cut margin of the mylo-hyoid muscle. 16. Anterior pillar of the palate (ant. half-arch), presenting a triangular figure with the base inferiorly, covering partly the tonsil. 17. Posterior pillar (post. half-arch) of the palate. 18. Tonsil. 19. Follicular (mucous) glands at the base of the tongue. 20. Cavity of the larynx. 21. Ventricle of the larynx. 22. Epiglottis. 23. Cut os hyoides. 24. Cut thyroid cartilage. 25. Thyro-hyoid membrane. 26. Section of posterior portion of the cricoid cartilage. 27. Section of the anterior portion of the same cartilage. 28. Crico-thyroid membrane.

* Cases are related by Portal and Béclard, in which the carotid artery was punctured in opening an abscess in the tonsil. The result was immediately fatal hemorrhage. It should, however, be borne in mind that the artery usually injured is the tonsillar branch of the facial artery, and not the internal carotid. The surgical treatment of this accident is therefore ligature of the external carotid artery between its superior thyroid and lingual branches, and not ligature of the common carotid artery, as is often recommended.

tine branch of the internal maxillary. *Nerves* are furnished to it from the glosso-pharyngeal and from Meckel's ganglion.

Eustachian Tube. — This canal conveys air from the pharynx to the tympanum. Its orifice is situated opposite the back part of the inferior turbinated bone. The direction of the tube from the pharynx is upwards, backwards, and outwards; it is an inch and a half (*3.8 cm.*) long. The narrowest part is about the middle, and here its walls are in contact. Near the tympanum its walls are osseous, but towards the pharynx they are composed of fibro-cartilage and fibrous membrane. The cartilaginous end, about an inch (*2.5 cm.*) in length, projects between the origins of the levator and the tensor palati, and gives attachment to some of their fibres, and also some of the palato-pharyngeus, now called the salpingo-pharyngeus. It is situated at the base of the skull, in the furrow between the petrous portion of the temporal and the great wing of the sphenoid bone. It adheres closely to the bony furrow, as well as to the fibro-cartilage filling up the foramen lacerum medium. The orifice is not trumpet-shaped, as usually described, but an elliptical slit about half an inch (*13 mm.*) long, and nearly perpendicular. The fibro-cartilage bounds it only on the inner and upper part of the circumference; the integrity of the canal below is maintained by tough fibrous membrane.

The Eustachian tube is lined by a continuation of the mucous membrane of the pharynx, and covered by ciliated epithelium. That which lines the cartilaginous portion of the tube is thick and vascular, and gradually becomes thinner towards the tympanum. Hence, inflammatory affections of the throat or tonsils are liable to be attended with deafness, from temporary obstruction of the tube.

Mucous glands surround the orifice of the tube, and are similar in nature and function to the glands beneath the mucous membrane of the mouth, the palate, and the pharynx.

Hard Palate. — The hard palate, formed by the palatine plates of the maxillary and palate bones, is a resisting surface for the tongue in tasting, in mastication, in deglutition, and in the articulation of sounds. The tissue covering the bones is thick and close in texture, and firmly united to the asperities on the bones. But it is not everywhere of equal thickness. Along the raphé in the mesial line it is much thinner than at the sides; for this reason, the hard palate is in this situation more prone to be perforated in syphilitic disease.

A thick layer of glands (*glandulæ palatinæ*) is arranged in rows on either side of the hard palate. These glands become more numerous and larger towards the soft palate. Their orifices are visible to the naked eye. The mucous membrane has a very thick epithelial coat, which gives the white color to the palate. The descending palatine branch of the internal maxillary artery, and the palatine nerves from the maxillary, may be traced along each side of the roof of the mouth. The ramifications of these arteries and nerves supply the soft as well as the hard palate.

Mechanism of Deglutition. — With the anatomy of the parts fresh in your mind, consider for a moment the mechanism of deglutition. The food, duly masticated, is collected into a mass upon the back of the tongue; the mandible is then closed to give a fixed point for the action of the muscles which raise the os hyoides and larynx, and the food is carried back into the pharynx by the pressure of the tongue against the palate, at the same time that the pharynx is elevated and expanded to receive it (by the stylo-pharyngei on each side).* The food, having reached the pharynx, is prevented from ascending into the nasal passages by the approximation of the posterior palatine arches and the elevation of the soft palate, which thus forms a horizontal temporary roof to the pharynx; it is prevented from returning into the mouth by the pressure of the retracted tongue and the contraction of the anterior palatine arches: it cannot enter the larynx, because its upper opening is closed and protected by the falling of the epiglottis; † consequently, being forcibly compressed by the constrictors of the pharynx, the food passes into the œsophagus, through which it is conveyed into the stomach by the undulatory contraction of that tube.

The food passes with different degrees of rapidity through the different parts of its course, but most rapidly through the pharynx. The necessity of this is obvious, as the air-tube must be closed while the food passes over it, and the closure produces a temporary interruption to respiration. The progress of the food through the œsophagus is slow and gradual.

* The larynx being also elevated and drawn forwards, a greater space is thus left between it and the vertebræ for the distention of the pharynx.

† This falling of the epiglottis is effected, not by special muscular agency, but by the simultaneous elevation of the larynx and the retraction of the tongue. A perpendicular section through all the parts concerned is necessary to show the working of this mechanism.

DISSECTION OF THE LARYNX.

Situation and Relations. — The larynx is the upper dilated part of the windpipe, in which phonation takes place. It consists of numerous cartilages articulated together to form an open tube, and to protect the delicate structures concerned in vocalization.

It forms a prominence in the middle line of the neck, covered in front by the integument and cervical fasciæ, the sterno-hyoid, sterno-thyroid, and thyro-hyoid muscles, and the thyroid body. It has the large vessels of the neck on each side. Above, it is attached to the hyoid bone; below, it is continuous with the trachea; behind it is the pharynx, into the anterior part of which it opens.

Before commencing the dissection of the larynx the student should make himself acquainted with the cartilages which compose it and the ligaments which connect them, as seen in a dry preparation.

Os Hyoides. — This bone, named from its resemblance to the Greek Upsilon, is situated between the larynx and the tongue, and serves for the attachment of the muscles of the tongue. It may be felt immediately below, and one inch and a half (*3.8 cm.*) behind, the symphysis of the mandible. It is arched in shape, and consists of a body, two greater and two lesser cornua. The *body* (*basi-hyal*) is the thick central portion. Its anterior surface is convex and has a median vertical ridge, on each side of which are depressions for the attachments of muscles; its posterior surface is smooth, deeply concave, and corresponds to the epiglottis. The *greater cornua* (*thyro-hyals*), right and left, project backwards for about an inch and a half (*3.8 cm.*), with a slight inclination upwards, and terminate in blunt ends tipped with cartilage. In young subjects they are connected to the body of the bone by fibro-cartilage; this, in process of years, becomes ossified. The *lesser cornua* (*cerato-hyals*) are connected, one on each side, to the point of junction between the body and the greater cornua, by means of a little joint lined with synovial membrane, which admits of free motion. They are of the size of a barley-corn, and give attachment to the stylo-hyoid ligaments (Fig. 91).

Ligaments. — The os hyoides is connected with the thyroid cartilage by several ligaments, which contain a quantity of

elastic tissue. There is: 1. The *thyro-hyoid membrane*, a broad fibrous membrane, which proceeds from the superior border of the thyroid cartilage to the upper and posterior part of the hyoid bone. In front of this membrane there is a bursa, of which the use is to facilitate the play of the thyroid cartilage behind the os hyoides. The central portion is stronger than the lateral, and is called the *anterior thyro-hyoid ligament*. Through the lateral part of this membrane the superior laryngeal nerve and artery enter the larynx. 2. The right and left *lateral thyro-hyoid ligaments* extend between the extremities of the greater cornua of the os hyoides and the ascending cornua of the thyroid cartilage. They contain a small nodule of cartilage (*corpus triticeum*).

FIG. 91.—ANTERIOR VIEW OF OS HYOIDES.

1, 1. Anterior or convex surface of the body. 2, 2. Greater cornua. 3, 3. Articulation of the greater cornua with the body. 4, 4. Lesser cornua.

Cartilages of the Larynx.—The framework of the larynx is composed of nine cartilages, viz., the thyroid, the cricoid, the two arytenoid, the two cornicula laryngis, the two cuneiform cartilages, and the epiglottis. These are connected by joints and elastic ligaments, so that they can be moved upon each other by their respective muscles; the object of this motion being to act upon two elastic ligaments, called the *vocal cords* or *bands*, upon the vibration of which phonation depends.

Thyroid Cartilage.—This cartilage, so called because it shields the mechanism behind it, consists of two lateral halves (*alæ*), united at an acute angle in front, which forms the prominence termed the *pomum Adami*. This prominence presents a notch at its upper part, to allow it to play behind the os hyoides in deglutition. There is a bursa in front of it. Each ala is somewhat quadrilateral in form, and presents for examination two surfaces and four borders. The *outer surface* of each ala is marked by an oblique line passing downwards and forwards from the base of the upper cornu, which gives attachment to the sterno-thyroid and thyro-hyoid muscles. The smooth surface behind the ridge gives attachment to the inferior constrictor. The *inner surface* is smooth, slightly concave, and is covered with mucous membrane. In the acute angle in front there are attached from above downwards the epiglottis, the false or ventricular bands, and true vocal cords or bands, the thyro-arytenoidei and thyro-epiglottidei muscles. The *inferior* border

is slightly arched in the middle, affording attachment to the crico-thyroid membrane, and on either side presents a convex prominence, which gives attachment to the crico-thyroid muscle and the crico-thyroid membrane. The *superior* border is nearly horizontal, and affords attachment to the thyro-hyoid membrane. The *posterior* border is thick, rounded, and nearly vertical, and gives insertion to the stylo-pharyngeus and palato-pharyngeus muscles. This border terminates, above and below, in round projections called the *upper* and *lower cornua*. The upper is the longer; the lower articulates with the side of the cricoid cartilage (Figs. 92, 93).

Cricoid Cartilage. — This cartilage, named from its resemblance to a ring, is situated below the thyroid. It is not of equal depth all round. It is narrow in front, where it may be felt about a quarter of an inch (*6 mm.*) below the thyroid; from this part, the upper border gradually rises, so that, posteriorly, the ring is an inch (*2.5 cm.*) in vertical depth, and occupies part of the interval left between the alæ of the thyroid. In the middle of this broad posterior surface is a vertical ridge, on either side of which observe a superficial excavation for the origin of the crico-arytenoidei postici; to the lower part of the vertical ridge are attached some of the longitudinal fibres of the œsophagus. On its *upper* part are two oval slightly convex surfaces for the articulation of the arytenoid cartilages, between which is a concavity for the attachment of the arytenoideus. In front, its upper border presents a broad excavation to which the crico-thyroid membrane (on which is seen the crico-thyroid artery), is attached. On its *outer* surface, external to the depression for the crico-arytenoideus posticus, is an elevated facet which articulates with the inferior cornu of the thyroid cartilage. In front of this articular surface it gives attachment to the inferior constrictor of the pharynx. The *lower* border is straight, and is connected by fibrous membrane to the first ring of the trachea. The *inner* surface is smooth, and the upper border is elliptical, its lower being nearly circular. (Figs. 92, 93.)

Ligaments. — The thyroid cartilage is connected to the cricoid by a membrane — the *crico-thyroid*. It consists of a median triangular portion, composed mainly of elastic tissue, with its base directed downwards. The lateral portions are thin and membranous, extending as far backwards as the articular facets for the thyroid cartilage, and are intimately connected with the inferior vocal cords or vocal bands. Between the inferior cornu

of the thyroid cartilage and the cricoid there is a distinct joint, having a synovial membrane, and strengthened by a *capsular ligament.* The articulation allows of a movement revolving upon its own axis, and, consequently, permits the approximation of the two cartilages. (Fig. 94, p. 259).

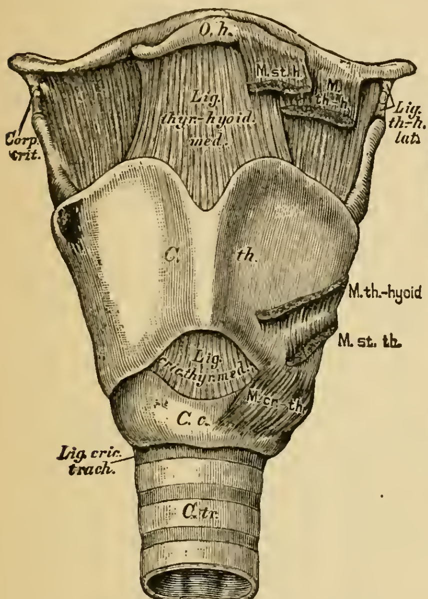


Fig. 92. — Larynx, Front View, with the Ligaments and Insertion of Muscles.

O. h., Os hyoides; *C. th.*, Thyroid cartilage; *Corp. trit.*, Corpus triticeum; *C. c.*, cricoid cartilage; *C. tr.*, Tracheal cartilage; *Lig. thyr.-hyoid med.*, Middle thyro-hyoid ligament: *Lig. th.-h. lat.*, Lateral thyro-hyoid ligament; *Lig. cric.-thyr. med.*, Middle crico-thyroid ligament; *Lig. cric.-trach.*, Crico-tracheal ligament; *M. ts.-h.*, Sterno-hyoideus muscle; *M. th.-hyoid.*, Thyro-Hyoideus muscle; *M. st.-th.*, Sterno-thyroideus muscle. *M. cr.-th.*, Crico-thyroideus muscle.

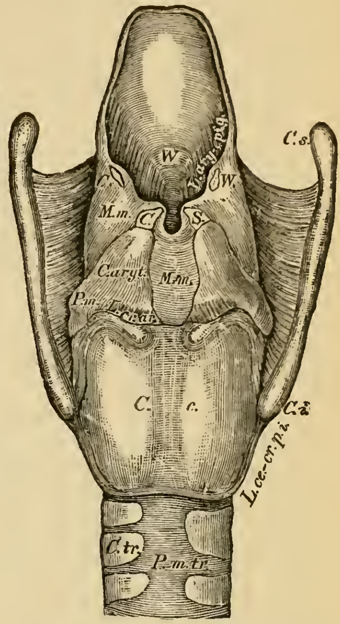


Fig. 93. — Posterior View of the Larynx, with the Muscles Removed.

E., Epiglottis cushion (W.); *L. ar.-ep.*, Aryteno-epiglottic fold or ligament; *M. m.*, Membrana mucosa; *C. W.*, Cartilage of Wiisberg or cuneiform; *C. S.*, Cartilage of Santorini or cornicula laryngis; *C. aryt.*, Arytenoid cartilage; *C. c.*, Cricoid cartilage; *P. m.*, Muscular process or external angle; *L. cr.-ar.*, Crico-arytenoid ligament; *C. s.*, Superior cornu; *C. i.*, Inferior cornu of the thyroid cartilage; *L. ce.-cr. p. i.*, Posterior inferior cerato-cricoid ligament; *C. tr.*, Tracheal cartilage; *P. m. tr.*, Membranous portion of the trachea.

Arytenoid Cartilages. — These cartilages are situated, one on each side, at the back of the upper border of the cricoid cartilage. In the recent state, before the membranes and muscles have been removed, the space between them resembles the lip of a pitcher; hence their name. Each is pyramidal, with the

apex upwards, is about one-half of an inch (*13 mm.*) in height, and one-quarter of an inch (*6 mm.*) in diameter at its base, and presents for examination three surfaces (marked off by three borders), a base and an apex. The *posterior* surface of each is triangular and concave, and gives attachment to the arytenoideus muscle ; the *anterior* surface is irregular and convex, affording attachment to the thyro-arytenoideus, and to the ventricular bands or false vocal cord; the *internal* surface, the narrowest and nearly flat, faces the corresponding surface of the opposite cartilage, and is covered with mucous membrane. The *base* is broad, and presents a smooth, somewhat concave, triangular surface, which articulates with the cricoid cartilage ; in front of the base is the pointed *anterior angle*, which gives attachment to the true vocal cord or vocal bands, and contributes to form part of the boundary of the rima glottidis ; at the outer and back part of the base is the *external angle*, into which certain muscles moving the cartilage are inserted, viz., the crico-arytenoideus posticus and crico-arytenoideus lateralis. The base is articulated with the cricoid by a joint which has a loose capsular ligament and a synovial membrane, permitting motion in all directions, like the first joint of the thumb. The *apex* is truncated and points backwards and inwards. It is surmounted by a cartilaginous nodule, called the *corniculum laryngis.*

Cornicula Laryngis.—Are two small conical cartilaginous nodules, and continue the direction of the arytenoid cartilages upwards and inwards.

Cuneiform Cartilages.— These cartilages, sometimes called the cartilages of Wrisberg, are conical in form, and somewhat curved, with their broader part directed upwards and forwards. They are contained in the aryteno-epiglottic fold. (Fig. 95, p. 260).

Epiglottis. — This piece of yellow fibro-cartilage is situated in the middle line, and projects over the larynx like a valve. It is like a leaf with its stalk directed downwards. Its ordinary position is perpendicular, leaving the upper opening of the larynx free for respiration ; but during the elevation of the larynx in deglutition it becomes horizontal, falls downwards and backwards over the larynx, and prevents the entrance of food into it. This descent of the epiglottis is accomplished, not by special muscular agency, but by the simultaneous elevation of the larynx and the retraction of the tongue. Its *apex* or lower part is attached by the *thyro-epiglottic ligament* to the angle of the thyroid cartilage ; it is also connected by an elastic ligament,

hyo-epiglottic, to the posterior surface of the os hyoides. *Laterally*, its borders are rather turned backwards, and to them are attached two folds of mucous membrane, which pass to the arytenoid cartilages, called the *aryteno-epiglottic folds.* Its *anterior surface* is only free at its base, where it is connected with the base of the tongue by the three *glosso-epiglottic folds.* Its *posterior* or *laryngeal surface* is smooth, concavo-convex and free, and looks towards the larynx. The surface of the epiglottis is closely invested by mucous membrane; this being removed, the yellow cartilage of the epiglottis is seen pitted and often perforated by the small mucous glands.

The cartilages of the larynx resemble those of the ribs in structure. In the young they are dense and elastic, but some have a tendency to ossify with age. In very old subjects the thyroid and cricoid cartilages are often completely ossified, and their interior presents an areolar tissue, containing oily matter, analogous to the spongy texture of the bones. The epiglottis, cornicula laryngis, and cuneiform cartilages are rarely ossified, on account of their consisting of yellow fibro-cartilage resembling that of the ear and nose.

The larynx must now be examined in its perfect condition.

Mucous Membrane of the Larynx. — The mucous membrane lines the whole of the interior of the larynx, being continuous above with that of the pharynx and mouth, below with that of the trachea. It is intimately adherent to the posterior part of the epiglottis and to the true vocal bands or cords; elsewhere it is loosely connected to the subjacent structures by an abundance of areolar tissue, which admits of its being elevated into large folds. This is chiefly found about the upper opening of the larynx, and it deserves notice from the rapidity with which it becomes the seat of serous effusion in acute inflammation of the larynx, and thus produces symptoms of suffocation. In the remaining part of the interior of the larynx the mucous membrane is moderately adherent to the subjacent tissues, and at the ventricular band or false vocal cord it reduplicates upon itself and then lines the sacculus laryngis. Naturally, the mucous membrane is of pale rose color, except where it covers the cushion of the epiglottis, where it is bright pink. It is covered by columnar ciliated epithelium below the ventricular bands or false vocal cords, and this variety is continued up the epiglottis as high as its middle; above this, by squamous epithelium. From the root of the tongue to the anterior surface of the epi-

glottis, the membrane forms three folds, *glosso-epiglottic*, one median, and two lateral, containing elastic tissue. From the epiglottis, to which it is intimately adherent, it is continued backwards on either side to the apices of the arytenoid cartilages, forming the *aryteno-epiglottic folds* which bound the upper entrance into the larynx.

The mucous membrane of the larynx is remarkable for its acute sensibility. This is requisite to guard the upper opening of the larynx during the passage of the food over it. The larynx is closed during the act of deglutition; but if, during this process, anyone attempt to speak or laugh, the epiglottis is raised, and allows the food to pass, as it is termed, the wrong way. As soon as the foreign body touches the mucous membrane of the larynx a spasmodic fit of coughing expels it.

The sub-mucous tissue of the larynx is studded with mucous glands. An oblong mass of them lies in the aryteno-epiglottic fold, and they are particularly numerous about the ventricles of the larynx. The surface of the epiglottis towards the tongue is abundantly provided with them. Their ducts pass through the epiglottis, and may be recognized as minute openings on its laryngeal aspect.

Superior Opening of the Larynx. — This is the opening through which the larynx communicates with the pharynx. Its outline is triangular, with its base directed forwards, and it slopes from before backwards. Anteriorly it is bounded by the epiglottis, laterally by the aryteno-epiglottic folds and cuneiform cartilages, posteriorly by the arytenoid cartilages and the cornicula laryngis. The apex presents the funnel-shaped appearance from which the arytenoid cartilages derive their name.

On looking down through this superior opening you see the *cavity of the larynx*, which is divided into an upper and a lower part by the narrow triangular fissure, called the *glottis*, or *rima glottidis;* so that the upper part gradually narrows to this chink, while the lower part gradually widens and becomes continuous at the lower border of the cricoid cartilage with the trachea.

The objects seen above the rima glottidis are, in the middle line, below the base of the epiglottis, a round elevation covered with mucous membrane of a bright pink color, termed the *cushion* of the epiglottis; on each side is an arched fold, the ventricular bands or *false vocal cords*, with their concavity looking downwards, and forming the upper boundary of a small

recess, the *ventricle of the larynx*, leading into a pouch, called the *sacculus laryngis*; below this are the two white bands, the vocal bands or *true vocal cords*, which form the boundaries of the glottis. The larynx below the vocal bands gradually enlarges and presents nothing calling for special description.

Glottis, or Rima Glottidis.—The *rima glottidis* is the triangular horizontal opening between the vocal bands. Its apex is directed forwards, its base backwards. The anterior two-thirds of this opening is bounded by the vocal bands, the posterior third by the arytenoid cartilages. The length in the male is nearly an inch (*24 mm.*), its width at rest from one-fourth to one-third of an inch (*6 to 8 mm.*); in the female its length is two-thirds of an inch (*16 mm.*), its width one-sixth of an inch (*4 mm.*). Before the age of puberty these dimensions are much less.

Ventricular Bands.—These are the prominent crescentic folds of mucous membrane which form the upper boundaries of the ventricles and inclose within them thin ligamentous fibres, called the *superior thyro-arytenoid ligaments*. They are called the *false vocal cords* because they have little or nothing to do with the production of the voice. They are composed of elastic tissue like the vocal bands; but they also contain fatty tissue, which the vocal bands do not.

Vocal Bands.*—These two bands, called also the *inferior thyro-arytenoid ligaments*, are composed of yellow elastic tissue, and extend horizontally from the angle of the thyroid cartilage to the anterior angles of the base of the arytenoid cartilages. Their inner or free edges are thin and sharp, and look upwards; their outer borders are continuous with the crico-thyroid membrane, and are in contact with the thyro-arytenoidei muscles. They diverge as they pass backwards, and are covered with very thin and closely adherent mucous membrane, having columnar epithelium. We shall

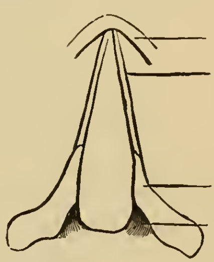


FIG. 94.—SHAPE OF THE GLOTTIS WHEN AT REST.

[* The editor desires to emphasize the change of cord to band, false vocal to ventricular, for anatomical reasons which to any dissector are apparent. Ventricular band locates the position and does away with the explanation that this portion has nothing to do with phonation.—A. H.]

presently see that, by the muscles which act upon the arytenoid cartilages, these bands can be approximated or separated from each other; in other words, the rima glottidis can be closed or dilated. When sufficiently tightened, and brought parallel by means of certain muscles, the bands are made to vibrate by the current of the expired air, and thus is produced sound.

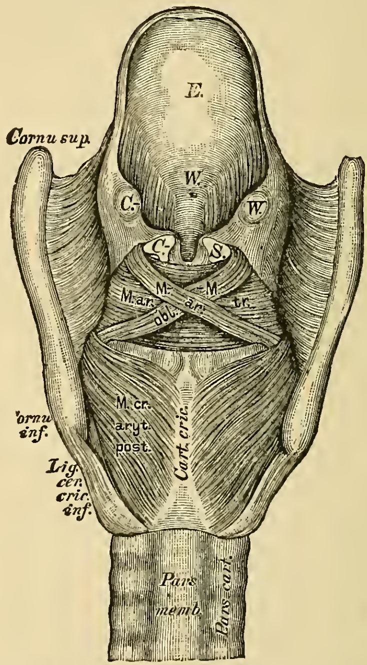


Fig. 95. — Posterior View of the Larynx, with its Muscles.

E., Epiglottis, with the cushion (W.); *C.W.*, Cartilage of Wrisberg: *C.S.*, Cartilage of Santorini; *Cart. cric.*, Cricoid cartilage; *Cornu sup.*, Superior cornua of the thyroid cartilage M. ar. tr., Transverse portion of the arytenoideus; Mm. ar. obl., Oblique portion of the arytenoideus, M. cr. aryt. post., Crico-arytenoideus muscle; *Pars cart.*, Cartilaginous rings of the trachea; *Pars memb.*, Tracheal membrane.

In the adult male the vocal bands measure about seven-twelfths of an inch (*14 mm.*); in the female about five-twelfths of an inch (*11 mm.*), In boys they are shorter; hence their peculiar voice. At puberty the bands lengthen and the voice breaks.

The glottis admits of being dilated, contracted, and even completely closed, by its appropriate muscles. When at rest its shape is triangular, as shown in Fig. 94, where the arytenoid

cartilages are cut through on a level with the vocal cords. During every inspiration the glottis is dilated by the crico-arytenoidei postici; it then becomes pear-shaped (Fig. 97). During expiration it resumes its triangular shape, and this return to a

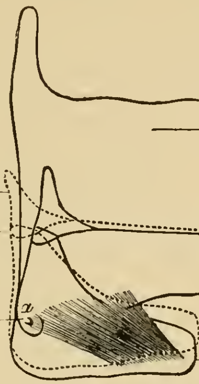


FIG. 96.—DIAGRAM SHOWING THE ACTION OF THE CRICO-THYROID MUSCLE.

state of rest is effected, not by muscular agency, but by two elastic ligaments shown in Fig. 94, which draw the arytenoid cartilages together. Thus, then, the glottis, like the chest, is dilated by *muscular* tissue; like the chest, also, it is contracted by *elastic* tissue. In speaking or singing the glottis assumes

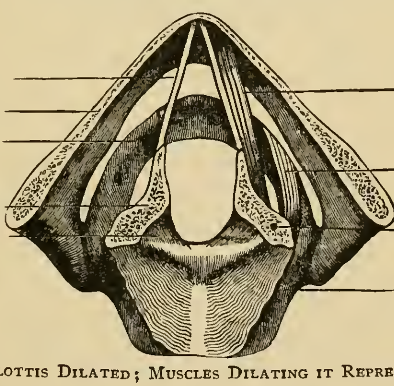


FIG. 97.—GLOTTIS DILATED; MUSCLES DILATING IT REPRESENTED WAVY.

what is called the vocalizing position—that is, the opening becomes narrower, and its edges nearly parallel.

Ventricles of the Larynx.—These are the recesses between the ventricular and vocal bands, and each leads to a

small conical pouch, the *sacculus laryngis*. Each ascends for about half an inch (*13 mm.*), as high as the upper border of the thyroid cartilage, which bounds it on its outer side, while on the inner side is the ventricular band. It contains from sixty to seventy muciparous glands. Over its inner and upper part is a layer of muscular tissue, *compressor sacculi laryngis* of Hilton (aryteno-epiglottideus inferior), which connects it with the aryteno-epiglottic fold; on its outer side is the upper part of the thyro-arytenoideus.

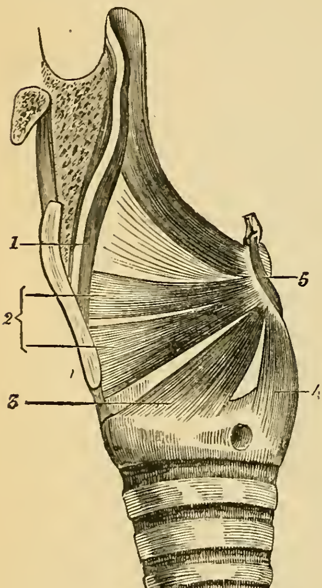


Fig. 98. — Side View of the Muscles of the Larynx.

1. Thyro-epiglottideus. 2. Thyro-arytenoideus, upper and lower portions. 3. Crico-arytenoideus lateralis. 4. Crico-arytenoideus posticus. 5. Arytenoideus.

Intrinsic Muscles of the Larynx. — There are eleven muscles which act upon the larynx, five on each side and one in the middle. The five pairs are the crico-thyroidei, the crico-arytenoidei postici, the crico-arytenoidei laterales, the thyro-arytenodei, and the aryteno-epiglottidei. The single one is the arytenoideus.

M. Crico-thyroideus. — This muscle is situated on the front of the larynx. It *arises* from the front and side of the cricoid cartilage, ascends obliquely outwards, and is *inserted* into the inferior border and lower cornu of the thyroid. Its *action* is to tighten the vocal cords. It does this by raising the anterior part of the cricoid cartilage, since this cartilage cannot be raised without lengthening these cords, as shown by the dotted line, Fig. 96. Its *nerve* is the *external laryngeal* branch of the superior laryngeal. Between the anterior borders of the two muscles is seen the crico-thyroid membrane, which is divided in laryngotomy.

M. Crico-arytenoideus Posticus. — This muscle *arises* from the broad depression on the posterior part of the cricoid cartilage; its fibres converge and pass outwards and upwards, to be *inserted* into the outer angle of the base of the arytenoid (Fig. 95 p. 260). Its *action* is to dilate the glottis. It does this by

drawing the posterior tubercle of the arytenoid cartilage *towards* the mesial line, and therefore the anterior angle (to which the vocal cord is attached) *from* the mesial line (Fig. 97). In this movement the arytenoid cartilage rotates as upon a pivot, and acts as a lever of the first order, the fulcrum or ideal pivot being intermediate between the power and the weight. This muscle dilates the glottis at each inspiration. Its *nerve* comes from the inferior laryngeal.

M. Arytenoideus. — This single muscle is situated immediately at the back of the arytenoid cartilages. The fibres pass across from one cartilage to the other, running in a transverse direction. *Action.* — By approximating the arytenoid cartilages, they assist in contracting the glottis. It is *supplied* by the inferior laryngeal *nerve.*

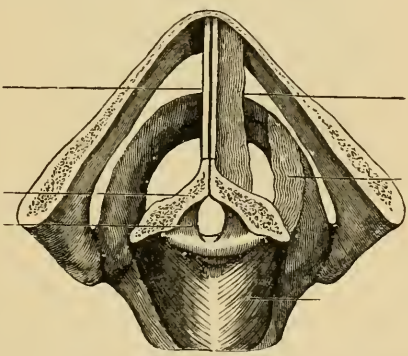


Fig. 99. — Glottis Closed; Muscles Closing it Represented Wavy.

M. Aryteno-epiglottis. — This muscle *arises* from the inferior and outer angle of the arytenoid cartilage, and, crossing its fellow like the letter X, is *inserted* partly into the apex of the opposite arytenoid cartilage and partly into the aryteno-epiglottic fold. This is sometimes spoken of as part of the arytenoideus.

M. Crico-arytenoideus Lateralis. — To expose this muscle reflect the crico-thyroid muscle, the crico-thyroid membrane, and then cut away the ala of the thyroid cartilage. It *arises* from the upper border of the side of the cricoid cartilage, and the fibres, passing backwards and upwards, converge to be *inserted* into the external angle of the base of the arytenoid, in front of the cricoid-arytenoideus posticus. *Action.* — By drawing the arytenoid cartilages inwards, the muscles of opposite sides con-

tract the glottis (Fig. 99). Its *nerve* comes from the inferior laryngeal.

M. Thyro-arytenoideus. — This muscle *arises* from the side of the angle of the thyroid cartilage and the crico-thyroid membrane, runs horizontally backwards, and is *inserted* into the base and anterior surface of the arytenoid. Its fibres run parallel with the true vocal cord, and some of them are directly

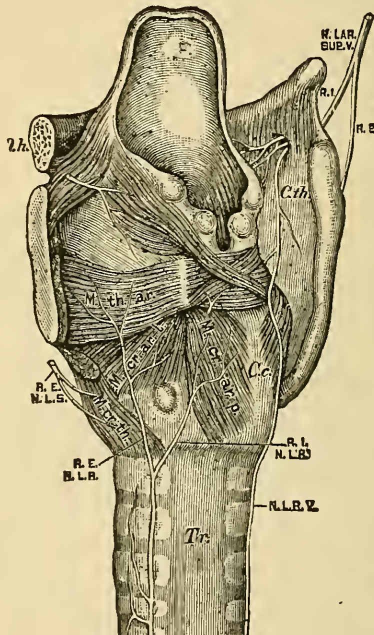


Fig. 100. — Nerves of the Larynx.

O. h., Os hyoides; *C. th.*, Thyroid cartilage; *C. C.*, Cricoid cartilage; *Tr.*, Trachea; M. th -ar., Thyro-arytenoideus muscle; M. cr.-ar. p., Posterior crico-arytenoideus muscle; M. cr -ar L., Lateral crico-arytenoideus muscle; M. cr.-th., Crico-thyroides muscle; N. lar. sup v, Superior laryngeal nerve; R. I., Internal branch; R. E., External branch; N. L. R. V., Recurrent laryngeal nerve; R. I. N. L. R., Internal branch of the recurrent nerve; R. E. N. L. R., External branch of the recurrent laryngeal nerve.

inserted into it. It consists of two fasciculi — an upper and a lower. The *lower* and larger portion is inserted into the anterior angle and the anterior surface of the arytenoid; the *upper* is inserted into the upper part of the anterior surface and the anterior border of the arytenoid. Its *nerve* comes from the inferior laryngeal (Fig. 100).

This muscle relaxes the vocal cord. More than this, it puts

the lip of the glottis in the vocalizing position; in this position the margins of the glottis are parallel, and the chink is reduced to the breadth of a shilling.

The following table shows the action of the several muscles which act upon the glottis:—

Crico-thyroidei, ...	Stretch the vocal bands.
Thyro-arytenoidei, ...	Relax the vocal bands, and place them in the vocalizing position.
Crico-arytenoidei postici, . .	Dilate the glottis.
Crico-arytenoidei laterales, . .	Draw together the arytenoid cartilages } close the glottis.
Arytenoideus, ...	Ditto ditto ditto } close the glottis.
Aryteno-epiglottidei, ...	Contract the upper opening of the larynx.

The epiglottis is connected by muscles with the arytenoid and thyroid cartilages: they are the thyro-epiglottideus, the aryteno-epiglottideus superior and inferior.

The *thyro-epiglottideus* is a thin muscle, *arising* from the angle of the thyroid cartilage just above the thyro-arytenoideus, and is *inserted* by diverging fibres into the border of the epiglottis and into the aryteno-epiglottic fold.

The *aryteno-epiglottideus superior* passes as thin muscular fibres from the tip of the arytenoid cartilage to the mucous membrane attached to the side of the epiglottis.

The *aryteno-epiglottideus inferior*, separated from the preceding by a distant interval, *arises* from the anterior surface of the arytenoid cartilage, and is *inserted* into the upper and inner part of the epiglottis. This muscle is also called the *compressor sacculi laryngis* of Hilton.*

The *blood-vessels of the larynx* are derived from the *superior* and *inferior thyroid arteries*. The laryngeal branch of the superior thyroid passes through the thyro-hyoid membrane with the corresponding nerve, and divides into branches, which supply the muscles and the mucous membrane. The laryngeal branches of the inferior thyroid ascend behind the cricoid cartilage. A constant little artery passes through the crico-thyroid membrane.

The *nerves* of the larynx are the *superior* and *inferior* (*recurrent*) *laryngeal* branches of the pneumogastric. (Fig. 100.)

The *superior laryngeal*, having passed through the thyro-hyoid membrane, divides into branches, distributed to the mucous membrane of the larynx. Its filaments spread out in various

* The *triticeoglossus* is a small muscle frequently present; it arises from the corpus triticeum, and passing forwards and upwards joins the cerato-glossus to be inserted into the tongue.

directions: some to the anterior and posterior surfaces of the epiglottis, and to the aryteno-epiglottidean folds, others to the interior of the larynx and the vocal bands and membranes. A constant filament descends behind the ala of the thyroid cartilage, and communicates with the inferior laryngeal, and another communication with the same nerve is found behind the larynx beneath the pharyngeal mucous membrane. Its external laryngeal branch supplies the crico-thyroid muscle.

The *inferior* (or *recurrent*) *laryngeal nerve* enters the larynx beneath the inferior constrictor, and ascends behind the joint between the thyroid and cricoid cartilages. It supplies all the intrinsic muscles of the larynx except the crico-thyroid. If the recurrent nerve be divided or in any way injured, the muscles moving the glottis become paralyzed, but its sensibility remains unimpaired. When the nerve is compressed by a tumor — for instance, an aneurism of the arch of the aorta — the voice is changed to a whisper, or even lost.

Difference between the Male and the Female Larynx. — Until the approach of puberty, there is no great difference in the relative size of the male and female larynx. The larynx of the male, within two years after this time, becomes nearly doubled in size; that of the female grows, but to a less extent.

The larynx of the adult male is in all proportions about one-third larger than that of the adult female.

The alæ of the thyroid cartilage form a more acute angle in the male; hence the greater projection of the pomum Adami and the greater length of the vocal cords in the male.

The average length of the vocal bands is in the	Male	$\frac{7}{12}$ of	an inch	(*14 mm.*)
	Female	$\frac{5}{12}$ of	" "	(*11 mm.*)
The average length of the glottis is in the . .	Male nearly		" "	(*24 mm.*)
	Female	[illegible] of	" "	(*16 mm.*)

The size of the larynx does not necessarily follow the proportions of the general stature; it may be as large in a little person as in a tall one; this corresponds with what we know of the voice.

DISSECTION OF THE TONGUE.

The tongue is a complex muscular organ, subservient to taste, speech, suction, mastication, and deglutition. It is situated in the space formed by the lower dental arch; its upper surface is convex and free, as is also its anterior part or tip, which lies behind the lower incisor teeth; its posterior and inferior part is connected to the os hyoides by the hyo-glossi, to the styloid process of the temporal

bone by the stylo-glossi, and to the symphysis of the mandible by the genio-hyo-glossi muscles.

The upper surface or *dorsum* is convex, and slopes on all sides from the centre; it is divided into two symmetrical halves by a median groove — *raphé* — running along the middle, and terminates posteriorly in a depression — the *foramen cæcum* — into which open several mucous glands. The posterior third of the dorsum is comparatively smooth; the anterior two-thirds is rough, and covered with small eminences called *papillæ.*

Mucous Membrane. — The surface of the tongue is covered with mucous membrane, which is composed of structures similar to those of the skin generally — that is to say, it consists of a cutis vera with numerous elevations called papillæ, and of a thick layer of squamous epithelium. The cutis is much thinner than that of the skin of the body, and affords insertion to some muscular fibres of the tongue.

The mucous membrane on the *under aspect* of the tongue is smooth and comparatively thin, and, in the middle line in front, forms a fold — the *frænum linguæ* — which connects it to the mucous membrane of the floor of the mouth. On each side of the frænum are the elevated orifices of the submandibular ducts; and further back, in the furrow between the tongue and gums, are the openings of the sublingual ducts. *Laterally*, the mucous membrane is reflected from the under part of the tongue to the mandible, and forms the floor of the mouth.

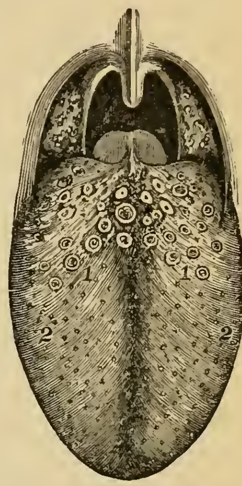


FIG. 101. — UPPER SURFACE OF THE TONGUE, WITH THE FAUCES AND TONSILS.

1. Papillæ circumvallatæ.
2. Papillæ fungiformes.

From the posterior part of the tongue the mucous membrane passes to the soft palate on each side, forming the folds termed the *anterior palatine arches*, which enclose the palato-glossi; there are also three folds to the epiglottis, termed the *glosso-epiglottic*, *two lateral* and *one median*, the latter enclosing a layer of elastic tissue called the *glosso epiglottic ligament.* This ligament raises the epiglottis when the tongue is protruded from the mouth; hence the rule of never pulling the tongue forwards when passing a tube into the œsophagus, otherwise the tube might pass into the larynx.

Papillæ of the Tongue. — The anterior two-thirds of the tongue is studded with numerous small eminences called *papillæ;* these, according to their size and form, are distinguished into three kinds, viz., *papillæ circumvallatæ*, *papillæ fungiformes*, and *papillæ filiformes* (Fig, 101).

The *papillæ circumvallatæ* vary in number from eight to twelve, and are arranged at the back of the tongue in two rows, which converge like the branches of the letter V, with the apex backwards, towards the foramen cæcum. Each of these papillæ is circular, from the $\frac{1}{30}$th to $\frac{1}{12}$th of an inch (*.8 mm. to 1 mm.*) wide, and slightly broader above than below. Each is surrounded by a circular fossa, which itself is bounded by an elevated ring (*vallum*).

The *papillæ fungiformes*, smaller and more numerous than the *circumvallatæ*, are scattered chiefly over the sides and tip of the tongue, and sparingly over its upper surface. They vary in shape, some being cylindrical, others having rounded heads like mushrooms: whence their name. Near the apex of the tongue they may be distinguished during life from the other papillæ by their redder color. In scarlatina, and some exanthematous fevers, these papillæ become elongated, and of a bright red color; as the fever subsides, their points acquire a brownish tint, giving rise to what is called the strawberry tongue.

The *papillæ filiformes* (*conicæ*) are the smallest and most numerous. They are so closely aggregated that they give the tongue a velvet-like appearance. Their points are directed backwards, so that the tongue feels smooth if the finger be passed over it from apex to base, but rough if in the opposite direction. These papillæ consist of small conical processes arranged for the most part in a series of lines running parallel to the two rows of the papillæ circumvallatæ. Each papilla is covered with a thick layer of epithelium, which is prolonged into a number of free hair-like processes.

The papillæ are covered with one or more layers of squamous epithelium. That which covers the filiform is superimposed so thickly as to give it sometimes the appearance of a brush when seen under the microscope. The various kinds of fur on the tongue consist of thick and sodden epithelium.

Glands. — Numerous small racemose and acino-tubular glands, *lingual glands*, are found in the submucous tissue at the root of the tongue. They are similar in structure and secretion to the tonsilar and palatine glands, so that there is a complete ring of glands round the isthmus faucium. Small round orifices upon their surface indicate the termination of their ducts. Other mucous glands, with ducts from one-quarter to half an inch long, are situated in the muscular substance of the tongue.

Lymphoid Tissue. — A considerable amount of *lymphoid tissue* is situated at the back of the tongue, which in some parts is collected into definite masses called *follicles*. Small depressions also occur in this situation, whose walls are studded with lymphoid tissue, and into which some of the mucous glands open.

Glands beneath the Apex of the Tongue. — On the inner surface of the apex of the tongue is placed, on either side, a group of glands presumed to be salivary. Considering each group as one gland, observe that it is oblong, with the long diameter from $\frac{7}{12}$ to $\frac{5}{8}$ of an inch (*15 to 21 mm.*), parallel with the axis of the tongue. It lies near the mesial line, a little below the ranine artery, on the outer side of the branches of the gustatory nerve, under some of the fibres of the stylo-glossus. Four or five ducts proceed from each group, and terminate by separate orifices on the under surface of the tongue.

Muscular Fibres of the Tongue. — The substance of the tongue is composed of muscular fibres and of a small quantity of fat. The *extrinsic* muscles of the tongue have been described in the dissection of the submandibular region (p. 116). We have now to examine its *intrinsic* muscles. For this purpose the mucous membrane must be removed from the dorsum of the tongue. On dissection it will be found that the great bulk of the organ consists of fibres which proceed in a longitudinal direction, constituting the *linguales* muscles.

The *superficial lingualis* runs longitudinally beneath the mucous membrane of the dorsum; its fibres are attached posteriorly to the hyoid bone and run forwards to the front and margin of the tongue. Posteriorly the muscle is thin and is covered by the fibres of the palato-glossus and hyo-glossus.

The *inferior lingualis* is larger than the preceding, and is situated on the under aspect of the tongue between the genio-hyo-glossus and the hyo-glossus. It may be readily exposed by dissecting the under surface of the tongue immediately on the outer aspect of the genio-hyo-glossus. It *arises* posteriorly from the hyoid bone and the substance of the tongue, and its fibres pass forwards to the tip of the tongue after being reinforced by fibres from the stylo-glossus. On its under aspect it is in relation with the ranine artery.

The *transverse fibres* form a considerable part of the thickness of the tongue and arise from the fibrous septum. They pass outwards between the superficial and inferior linguales, ascending as they near the sides of the tongue, where the fibres become continuous with those of the palato-glossus. A considerable amount of fat is found among these fibres.

The *vertical fibres* run in a curved direction, descending from the dorsum to the under aspect of the tongue, with the concavity outwards. They interlace with the transverse fibres and with the genio-hyo-glossus.

On tracing the genio-hyo-glossi into the tongue, we find that some of their fibres ascend directly to the surface; others cross in the middle line, intersect the longitudinal fibres, and finally terminate upon the sides of the tongue. Lastly, the fibres of the stylo-glossi should be traced along the side of the tongue to the apex.

Fibrous Septum of the Tongue. — The *fibrous septum* of the tongue is a vertical plane of fibrous tissue which extends, in the mesial line, from the base to the apex. It is thick posteriorly, where it is connected behind with the hyoid bone, and is lost in front between the muscles. In it is sometimes found a piece of fibro-cartilage, called *nucleus fibrosus linguæ*, a representative of the lingual bone in some of the lower animals.

The *arteries* supplying the tongue are the dorsal and ranine branches of the lingual arteries. It is important to bear in mind that the arteries do not anastomose across the middle line, and only very slightly at the apex, so that it is possible to cut along the septum of the tongue from the apex to the base with very little hæmorrhage, — a fact of much importance in the removal of the tongue or cancer of that organ.

The *nerves* to the tongue should now be followed to their termination. The *hpyoglossal* supplies with motor power all the muscles. The *gustatory* or *lingual* branch of the mandibular division of the fifth is distributed to the mucous membrane and papillæ of the apex and sides of tongue, supplying the anterior two-thirds with common sensations. Upon this nerve depends the sensation of all ordinary impressions, such as that of hardness, softness, heat, cold, and the like.

The *glosso-pharyngeal* nerve supplies the mucous membrane at the back and the sides of the tongue, and the papillæ circumvallatæ. Under the microscope small ganglia may be distinguished on the terminal fibres of this nerve.

DISSECTION OF THE MAXILLARY NERVE.

To trace this nerve and its branches we must remove the outer wall of the orbit as far as the foramen rotundum, so as to expose the spheno-maxillary fossa.

The maxillary nerve is a sensory nerve, and is the second division of the fifth cranial nerve. Proceeding from the Gasserian ganglion (Fig. 102), it leaves the skull through the foramen rotundum, and passes horizontally forwards across the spheno-maxillary fossa. It then passes into the orbit through the spheno-maxillary fissure, enters the infra-orbital canal with the corresponding artery, and finally emerges upon the face, through the infra-orbital foramen, beneath the levator labii superioris, where it divides into a number of spreading branches, distributed to the lower eyelid, the nose, and the upper lip. The branches given off are: —

1. Within the skull.

a. A *recurrent branch*, to the dura and middle meningeal artery, is given off near the Gasserian ganglion.

2. In the spheno-maxillary fossa.

b. The *orbital branch* already described (p. 77).

c. Two *spheno-palatine branches* which descend to the spheno-palatine ganglion (Meckel's), situated in the spheno-maxillary fossa (Fig. 102).

d. The *dental branches* are three in number: the two posterior are given off immediately before the nerve enters the infra-orbital canal, and descends along the tuberosity of the maxillary bone; the anterior is given off in the intra-orbital canal. The *posterior* branch divides into two branches, which send small filaments to the gums and the mucous membrane of cheek, and then run in bony canals in company with small arteries to supply the molar teeth and the antrum; the *middle* branch passes down in a special canal in front of the antrum to be distributed to the bicuspid teeth; the *anterior* branch, the largest, is given off before the nerve emerges from the infra-orbital foramen, and enters the canal in the front wall of the antrum; it divides into *dental* branches for the supply of the canine and incisor teeth, and into a *nasal* branch for the mucous membrane of the floor of the nasal fossa. The anterior branch while in its bony canal gives off some filaments, which join with the posterior dental branches, and above the canine fossa it also forms a communication with a nasal branch from the spheno palatine ganglion to form the *ganglion of Bochdalek*.

e. The terminal branch of the maxillary nerve is called the *infra-orbital*, which divides on the face into palpebral, nasal, and labial branches. These have been already dissected and described (p. 62).

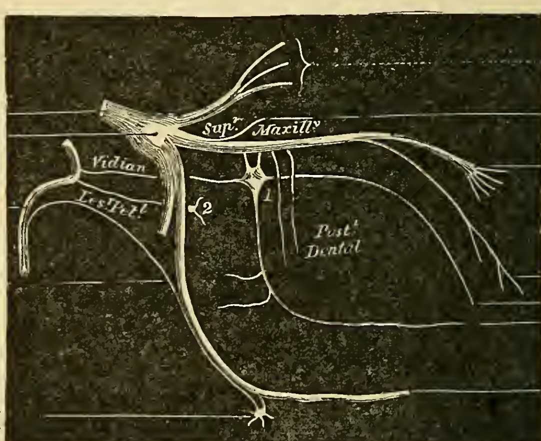


FIG. 102.—DIAGRAM OF THE MAXILLARY NERVE.

1. Spheno-palatine ganglion. 2. Otic ganglion.

Dissection.—At this stage the student should make the dissection to expose the spheno-palatine ganglion and its branches. To do this it is necessary to saw through the skull rather on one side of its middle line, so as to expose the cavity of the nose. Search must now be made for the spheno-palatine foramen (just external to which is the spheno-palatine ganglion), which is situated immediately above the posterior extremity of the middle turbinated bone. Remove the mucous membrane at this point, when the terminal branch of the internal maxillary artery, which comes through this foramen into the nose, may

be readily made out. The student should next cut away the thin plate of bone which forms the inner boundary of the posterior palatine canal. Then, by tracing upwards the branches contained within the canal, he will find the ganglion.

Spheno-palatine Ganglion. — This ganglion is called, after its discoverer, *Meckel's ganglion.* It is the largest of the ganglia in connection with the branches of the fifth cerebral nerve, is triangular, convex on its outer surface, of reddish-gray color, about one-fifth of an inch (*5 mm.*) in diameter, and is placed immediately below the maxillary nerve, as it crosses the spheno-

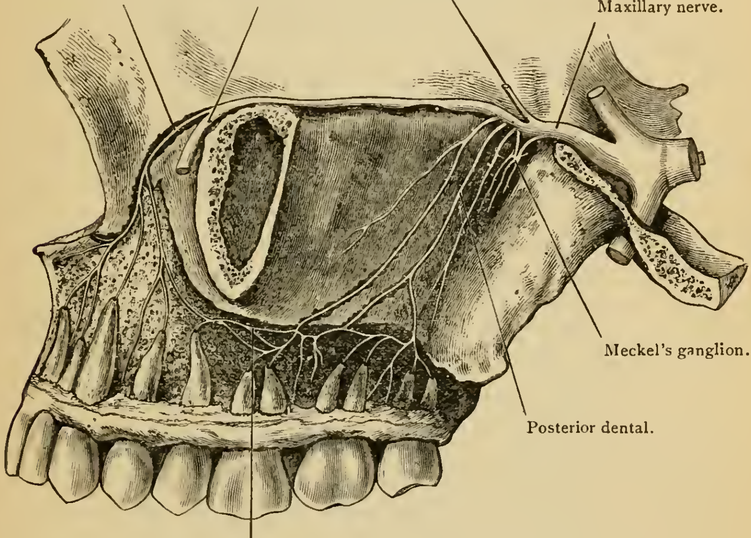


FIG. 103. — THE MAXILLARY NERVE SEEN FROM WITHOUT. (Beaunis.)

maxillary fossa. Like other ganglia, it has three roots — a *sensory*, from the maxillary ; a *motor*, from the great petrosal branch of the fascia ; and a *sympathetic*, from the carotid plexus.

Its branches pass *upwards* to the orbit, *downwards* to the palate, *inwards* to the nose, and *backwards* to the pharynx, as follows : —

a. Ascending branches. — These are very small, and run through the spheno-maxillary fissure to be distributed to the periosteum of the orbit.*

* Anatomists describe several branches ascending from the ganglion ; one to join the sixth nerve (Böck) ; another to join the ophthalmic ganglion (Tiedemann) ; and, lastly, some to join the optic nerve through the ciliary branches (Hirzel).

b. Descending branches. — To see these the mucous membrane must be removed from the back part of the nose; we shall then be able to trace the nerves through their bony canals. Their course is indicated by their accompanying arteries. They descend through the palatine canals, and are three in number. The *anterior palatine* nerve, the largest, descends through the posterior palatine canal to the roof of the mouth, and then divides into branches, which run in grooves in the hard palate nearly to the gums of the incisor teeth, where it communicates with the naso-palatine nerve. Within its canal it sends two *inferior nasal branches* which enter the nose through foramina in the palate bone to supply the membrane on the middle and lower spongy bones. The *posterior or smaller palatine* descends in the same canal with the anterior, or in a smaller one of its own, and supplies the mucous membrane of the soft palate, the tonsil, and (according to Meckel) the levator palati muscle.* The *external palatine* may be traced in a special canal down to the soft palate, where it terminates in branches to the uvula, the palate, and tonsil. The two last branches communicate with the tonsilar filaments of the glosso-pharyngeal to form the *tonsilar plexus of nerves.*

c. Internal branches. — These, three or four in number, pass through the spheno-palatine foramen to the mucous membrane of the nose. To see them clearly the parts should have been steeped in dilute nitric acid; afterwards, when well washed, these minute filaments may be recognized beneath the mucous membrane covering the turbinated bones. The *upper nasal* branches, four or five in number, pass inwards, and are distributed on the two upper spongy bones, the upper and back part of the septum, and the posterior ethmoidal cells. The *naso-palatine* (nerve of Contunnius) traverses the roof of the nose, distributes branches to the back part of the septum narium, and then proceeds obliquely forwards, along the septum, to the foramen incisivum, through which it passes, and finally terminates in the palate behind the incisor teeth, communicating here with the anterior palatine nerve.

d. Posterior branches. — The *pharyngeal nerve* (pterygo-palatine), very small, comes off from the back of the ganglion, and, after passing through the pterygo-palatine canal with its corresponding artery, supplies the mucous membrane of the back of the pharynx and the Eustachian tube. The *Vidian nerve* is the principal branch. It proceeds backwards from the posterior part of the ganglion, through the Vidian canal, where it distributes small branches to the back part of the roof of the nose and septum. It then traverses the fibro-cartilage of the foramen lacerum medium, and divides into two branches. Of these two branches one, the larger — the *carotid* — joins the sympathetic plexus on the outer side of the internal carotid artery; the other — the *great petrosal* — enters the cranium and runs beneath the Gasserian ganglion and the dura in a small groove on the anterior surface of the petrous bone; it then enters the hiatus Fallopii, and joins the facial nerve in the aquæductus Fallopii.

It would seem to be more in accordance with modern views to regard the Vidian nerve, not as dividing to form the carotid and great superficial petrosal branches, but rather as formed by the junction of these branches. In this view the Vidian runs, not *from*, but *to*, the spheno-palatine ganglion.

Otic Ganglion. — The otic ganglion (Arnold's) is situated on the inner side of the mandibular division of the fifth nerve, immediately below its exit through the foramen ovale (Fig. 102, p. 270). It is oval, of reddish-gray color, and always small. Its *inner* surface is in contact with the circumflexus (*or tensor*) palati muscle and the cartilage of the Eustachian tube; *behind* it is the middle meningeal artery;

* According to Longet (*Anal. et Physiol. du Système Nerveux*, Paris, 1842) the posterior palatine nerve supplies the levator palati and the azygos uvulæ with motor power. In this view of the subject the nerve is considered to be the continuation or terminal branch of the motor root of the ganglion; that, namely, derived from the facial. This opinion is supported by cases in which the uvula is stated to have been drawn on one side in consequence of paralysis of the opposite facial nerve.

externally it is in relation with the mandibular nerve, where the motor root joins the sensory root.

This ganglion has branches of connection with other nerves; namely, a *sensory* from the auriculo-temporal nerve; a *motor* from the branch of the mandibular, which goes to the internal pterygoid muscle; and a *sympathetic* from the plexus around the arteria meningea media. It communicates also with the facial and the glosso-pharyngeal nerves by the *lesser petrosal* nerve. This branch passes back-

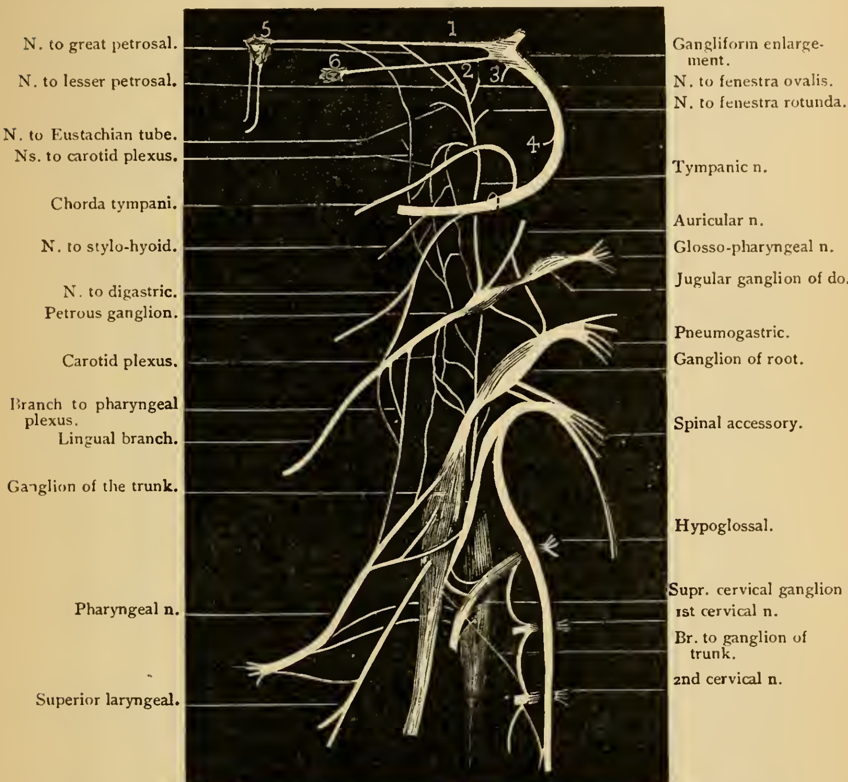


FIG. 104. — DIAGRAM OF THE COMMUNICATIONS OF THE FACIAL, GLOSSO-PHARYNGEAL, PNEUMOGASTRIC, SPINAL ACCESSORY, HYPOGLOSSAL, SYMPATHETIC, AND THE TWO UPPER CERVICAL NERVES.

1. Great petrosal nerve. 2. Lesser petrosal nerve. 3. External petrosal nerve. 4. Nerve to Stapedius muscle. 5. Spheno-palatine ganglion. 6. Otic ganglion.

wards, either through the foramen oval or the foramen spinosum, or through a small hole between them, and runs beneath the dura in a minute groove on the petrous bone, external to that for the *great petrosal* nerve. Here it divides into two filaments, one of which joins the facial nerve in the aquæductus Fallopii; the other joins the tympanic branch of the glosso-pharyngeal. These nerves are difficult to trace, not only on account of their minuteness, but because they frequently run in canals in the temporal bone.

The otic ganglion sends a branch forwards to the tensor palati, and one backwards to the tensor tympani, on the outer side of the Eustachian tube.

DISSECTION OF THE NINTH, TENTH, AND ELEVENTH CRANIAL NERVES AT THE BASE OF THE SKULL.

In this dissection we propose to examine the glosso-pharyngeal, pneumogastric, and spinal accessory nerves in the jugular fossa, and the ganglia and nerves belonging to them in this part of their course. These are difficult to trace, and cannot be followed unless the nerves have been previously hardened by spirit and the bones softened in acid. The next thing to be done is to remove the outer wall of the jugular fossa.

Glosso-pharyngeal Nerve, or Ninth Nerve. — This nerve emerges from the cranium through a separate tube of dura, in front of that for the tenth and eleventh cranial nerves. Looking at it from the interior of the skull, we notice that it is situated in front, and rather to the inner side of the jugular fossa, where it lies in a groove.

In its passage through the foramen, the nerve presents two enlargements, termed the *jugular* and the *petrous* ganglion.

The *jugular ganglion* (*ganglion of Ehrenritter*) is found upon the nerve immediately after its entrance into the canal of the dura, and averages about the one-twentieth of an inch (*1.25 mm.*) in length and breadth. It is situated on the outer side of the nerve, and does not implicate all its fibres. According to our observation, this ganglion is not infrequently absent (Fig. 97).

The *petrous ganglion* (*ganglion of Andersch*) is lodged in a groove in the lower part of the jugular fossa. It is oval, about a quarter of an inch (*6 mm.*) long, and involves all the filaments of the nerve. From it are given off branches of communication with other nerves and the tympanic nerve (Fig. 104).*

The *communicating branches* which connect this ganglion with the pneumogastric are, one to its auricular branch, and a second to the ganglion of the root.

It is also connected with the sympathetic by a small filament from the superior cervical ganglion. Another communicating branch pierces the posterior belly of the diagastricus to join the facial just external to the stylo-mastoid foramen.

The *tympanic nerve* (Jacobson's) ascends, through a minute canal in the bony ridge which separates the carotid from the jugular fossa, to the inner wall of the tympanum, grooving the surface of the promontory, where it terminates in six filaments. Of these, three are branches of distribution, and three of communication with other nerves. The *branches of distribution* are, one each to the fenestra rotunda and the fenestra ovalis, which pass backwards, and one to the Eustachian tube, which is directed forwards. The *branches of communication* are four small filaments; one or two traverse a bony canal in the anterior wall of the tympanum, and arching forwards, join the plexus on the outer side of the carotid artery; another, the *small deep petrosal nerve*, runs in a canal in the processus cochleariformis, passes through the foramen lacerum medium to join the carotid plexus; a third ascends in front of the fenestra ovalis, and, passing forwards, joins the great petrosal nerve in the hiatus Fallopii; the fourth leaves the front of the tympanum under the name of the *small superficial petrosal nerve*, through a canal, where it is joined by a filament from the geniculate ganglion of the facial nerve; then passing beneath the canal for the tensor tympani, it emerges through a foramen on the anterior surface of the pars petrosa, external to the hiatus Fallopii; it proceeds along the anterior surface of pars petrosa, and emerges from the skull between the great wing of the sphenoid and the petrous bones to join the otic ganglion. Thus the tympanic branch is distributed to the mucous membrane of

* This nerve, though commonly called Jacobson's, was fully described by Andersch.

the tympanum and the Eustachian tube, and communicates with the spheno-palatine ganglion through the great petrosal nerve, and with the otic ganglion through the lesser petrosal (Fig. 104).

Pneumogastric Nerve, or Tenth Nerve. — This nerve leaves the cranium with the nervus accessorius through a common canal in the dura, behind that for the glosso-pharyngeal. At its entrance into the canal it is composed of a number of separate filaments, which are soon collected into a single trunk. In the jugular foramen the nerve presents a ganglionic enlargement, 4 to 6 mm. in length, called the *ganglion of the root;* and, after the nerve has emerged from the jugular foramen, it presents a second ganglion, larger than that of the root fusiform in appearance, about 20 mm. in length and 4 to 5 mm. in thickness — the *ganglion of the trunk* of the nerve — where it is joined by the accessory portion of the spinal accessory nerve. It is connected by filaments with the sympathetic through the superior cervical ganglion, with the petrous ganglion of the glosso-pharyngeal, with the auricular branch of the facial, and with the spinal accessory by one or two branches. It gives off the *auricular branch,** which is distributed to the pinna of the ear. This branch, shortly after its origin, is joined by a branch from the petrous ganglion of the glosso-pharyngeal, and, passing outwards behind the internal jugular vein, it enters a minute foramen in the jugular fossa near the styloid process. It then proceeds through a canal in the bone, crosses the aquæductus Fallopii, where it communicates with the facial nerve, and passes to the outside of the skull through the fissure between the mastoid process and the meatus auditorius externus. It here divides into two branches, one being distributed to the skin of the auricle, and communicating with the great auricular nerve; the other communicating with the posterior auricular branch of the facial over the mastoid process. This ganglion also sends backwards a *meningeal branch,* which passes through the jugular foramen to be distributed to the dura of the posterior fossa (Fig. 104).

The *ganglion of the trunk* has communications with the hypoglossal nerve, with the loop formed between the first and second cervical nerves, and with the superior cervical ganglion of the sympathetic. It gives off, as branches of distribution, the pharyngeal and superior laryngeal nerves. This has been previously described (p. 158).

Facial or Seventh Nerve in the Temporal Bone. — The facial nerve is contained within the meatus auditorius internus, together with the auditory nerve. At the bottom of the meatus the two nerves are connected by one or more filaments. The facial nerve then enters the aquæductus Fallopii. This is a tortuous canal in the substance of the temporal bone, and terminates at the styloid-mastoid foramen. The nerve proceeds from the meatus auditorius internus for a short distance outwards towards the hiatus Fallopii, where it presents a ganglionic enlargement — the *intumescentia gangliformis,* or *geniculate ganglion* — where it is joined by several nerves; it then makes a sudden bend backwards along the inner wall of the tympanum above the fenestra ovalis, and, lastly, curving downwards along the back of the tympanum, it leaves the skull through the stylo-mastoid foramen.

Its *branches* of *communication* in the temporal bone are: —

Those in the meatus auditorius internus —

a. With the auditory nerve.

Those in the aquæductus Fallopii —

b. With Meckel's ganglion through the large petrosal nerve.

c. With the otic ganglion through the small superficial petrosal nerve.

d. With the sympathetic around the middle meningeal artery through the external superficial petrosal nerve.

* Arnold's nerve.

Its *branches* of *distribution* are: —

e. The tympanic branch.
f. The chorda tympani.

a. The *communicating branches* with the auditory are by several filaments, in the meatus auditorius internus.

b. The *large petrosal nerve* joins the carotid branch from the sympathetic to form the Vidian nerve, which joins the spheno-palatine ganglion (Fig. 105, 3).

c. The *small superficial petrosal nerve* passes along the anterior surface of the pars petrosa to join the otic ganglion below the foramen ovale (Fig. 105, 4).

d. The *external superficial petrosal nerve* passes from the geniculate ganglion to the sympathetic plexus around the middle meningeal artery (Fig. 105, 5).

e. The *tympanic branch* passes through a foramen in the base of the posterior pyramid to supply the stapedius and the laxator tympani (Fig. 104, 4).*

f. The *chorda tympani* is given off from the facial nerve before its exit from the stylo-mastoid foramen.† It ascends a short distance in a bony canal at the back of the tympanum, and enters that cavity through a small foraman — foramen chordæ posterius — below and external to the pyramid, close to the membrana tympani. It runs forwards, ensheathed in mucous membrane, through the tympanum, between the handle of the malleus and the long process of the incus, to the anterior part of that cavity. It emerges through a small aperture — foramen chordæ anterius — then traverses a special bony canal — canal of Huguier — and makes its exit close to the fissura Glaseri. It passes downwards and forwards between the two pterygoid muscles, behind the arteria meningea media, the auriculo-temporal and inferior dental nerves, to join, at an acute angle, the lower border of the gustatory nerve. It then proceeds in part to the submandibular ganglion, and in part to the lingualis muscle.

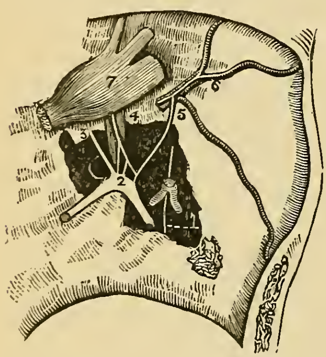


FIG. 105. — THE GENICULATE GANGLION OF THE FACIAL NERVE, AND ITS CONNECTIONS WITH THE OTHER NERVES. (*From Bidder.*)

1. The chorda tympani. 2. The geniculate ganglion of the facial nerve. 3. The great petrosal nerve. 4. The lesser petrosal nerve lying over the tensor tympani. 5. The external petrosal nerve communicating with the sympathetic plexus on the arteria meningea media (6). 7. The Gasserian ganglion.

External to the stylo-mastoid foramen, the facial nerve communicates with the pneumogastric, the glosso-pharyngeal, the great auricular, the auriculo-temporal nerves, and with the carotid plexus ; and on the face, with the numerous branches of the three divisions of the fifth nerve. Its branches of distribution, close to the stylo-mastoid foramen, are the posterior auricular, digastric, and stylo-hyoid branches ; and on the face, branches to all the facial muscles and the platysma myoides.

* This is often not muscular, but ligamentous in structure.

† In the fœtus this nerve is given off outside the foramen, but subsequently the bone grows downwards so as to enclose more of the facial nerve, and with it the chorda tympani.

Course of the Internal Carotid through Base of Skull. The cervical portion of the internal carotid has been already described (p. 157). Its subsequent course may be divided into the petrous, cavernous, and cerebral portions.

In the *petrous portion*, the artery takes a very tortuous course; at first it ascends for a short distance; it then curves forwards and inwards; and lastly, it again ascends to reach the side of the body of the sphenoid. It is situated in front of the tympanum, from which it is separated by a thin lamella of bone, which is frequently absorbed in advanced age. It gives off a *tympanic branch* to the tympanum and membrana tympani.

In the *cavernous portion*, the artery again makes a series of curves: at first it ascends forwards on the side of the body of the sphenoid, and then curves upwards on the inner side of the anterior clinoid process. The artery in this part of its course lies in the inner wall of the cavernous sinus, having the sixth nerve below and to its outer side. From this portion are given off *arteriæ receptaculi* to supply the *conarium* (pituitary body) Gasserian ganglion, and neighboring structures; the *anterior meningeal or predural* to supply the dura; and the *ophthalmic artery* already described (p. 72).

In the *cerebral portion*, it pierces the dura on the inner side of the anterior clinoid process, and is surrounded by a sheath of the arachnoid. It gives off the *anterior cerebral*, the *middle cerebral*, the *anterior choroid*, and the *posterior communicating arteries*.

The internal carotid is accompanied in the carotid canal by the cranial branch of the superior cervical ganglion of the sympathetic, described p. 163. Its position on the inner wall of the cavernous sinus, and the nervous plexuses upon it, are described at p. 39.

At this stage of the dissection we may conveniently trace the anterior divisions of the two upper cervical nerves.

Suboccipital Nerve. — The anterior division of the *first cervical* or *sub-occipital nerve* descends in front of the transverse process of the atlas to form a loop with the ascending branch of the second cervical nerve. It lies beneath the vertebral artery, on the inner side of the rectus capitis lateralis, to which it gives a branch; as also, one to the occipito-atloid joint, one to the rectus capitis anticus minor, and one to the sympathetic around the vertebral artery. From its loop of communication with the second nerve it gives filaments of communication to the superior cervical ganglion, to the hypoglossal and pneumogastric nerves; and muscular branches to the longus colli and rectus capitis anticus major.

Second Cervical Nerve. — The anterior division of this nerve emerges between the arches of the atlas and axis, and passes between the vertebral artery

and the intertransverse muscle, in front of which it subdivides into an ascending branch which joins the first cervical nerve, and into a descending which joins the third cervical nerve.

DISSECTION OF THE NOSE.

Presuming that the dissector is familiar with the bones composing the skeleton of the nose, we shall now describe: 1. The nasal cartilages; 2. The general figure and arrangement of the nasal cavities; 3. The membrane which lines them; and 4. The distribution of the olfactory nerves.

Cartilages of the Nose. — The framework of the external nose is formed by five cartilages; on each side by two lateral cartilages; and by one in the centre, which completes the septum between the nasal fossæ.

The *lateral cartilages* are termed, respectively, upper and lower, which are covered externally by integument, and are lined internally by mucous membrane. The *upper*, triangular in shape, is connected superiorly to the margin of the nasal and maxillary bones; anteriorly, which is its thickest part, to the cartilage of the septum; and, inferiorly, to the lower cartilage by means of a tough, fibrous membrane. The *lower* is elongated, and curved upon itself in such a way as to form not only half the apex, but the outer and inner boundaries of the external opening of the nostrils. Superiorly, it is connected by fibrous membrane to the upper cartilage; internally, it is in contact with its fellow of the opposite side, foiming the upper part of the columni nasi; posteriorly, it is attached by fibrous tissue to the maxillary bone; in this tissue are usually found two or three nodules of cartilage, called *cartilagines sesamoidæ;* below, it is firmly connected to dense connective tissue. By their elasticity these several cartilages keep the nostrils continually open, and restore them to their ordinary size whenever they have been expanded by muscular action.

The *cartilage of the septum* is placed perpendicularly in the middle line; it may lean a little, however, to one side or the other, and in some instances it is perforated, so that the two nasal cavities communicate with each other. The cartilage is smooth and flat, and its outline is nearly triangular.* The posterior border is received into a groove in the perpendicular plate of the ethmoid; the anterior border is much thicker than the rest of the septum, and is connected, superiorly, with the nasal bones, and on either side with the lateral cartilages. The inferior border is attached to the vomer and the median ridge at the junction of the palatine processes of the maxillæ.

The nose receives its *blood-supply* from the lateralis nasi, the artery of the septum, the facial, the nasal branch of the ophthalmic, and the infra-orbital arteries. The *veins* are returned to the facial and ophthalmic veins. The *nerves* are derived from the nasal branch of the ophthalmic, the infra-orbital, and infra-trochlear nerves. Its *muscles* are supplied by branches from the facial nerve.

The muscles moving the nasal cartilages have been described with the dissection of the face (p. 51).

Interior of the Nose. — A vertical section should be made through the right nasal cavity, a little on the same side of the middle line,† to expose the partly bony and partly catilaginous partition of the nasal cavities (*septum narium*). Each nasal fossa is narrower above than below. The greatest perpendicu-

* Cartilage said to be quadrangular. Freeman (*Univers. Med. Mag.*, vii., 1895, p 332). A. H.

† This has already been done in order to dissect the spheno-palatine ganglion.

lar depth of each fossa is about the centre; from this point the depth gradually lessens towards the anterior and the posterior openings of the nose. Laterally, each fossa is very narrow, in conseouence of the projection of the turbinated bones towards the septum: this narrowness in the transverse direction explains the rapidity with which swelling of the lining membrane from a simple cold obstructs the passage of air.

Boundaries of Nasal Fossæ. — The nasal fossæ are bounded by the following bones: — *superiorly*, by the nasal, the nasal spine of the frontal, the cribriform plate of the ethmoid, the body of the sphenoid, and the sphenoidal turbinated bones: *inferiorly*, by the horizontal plates of the maxillary and palate bones; *internally*, is the smooth and flat septum formed by the perpendicular plate of the ethmoid, the ridge formed by

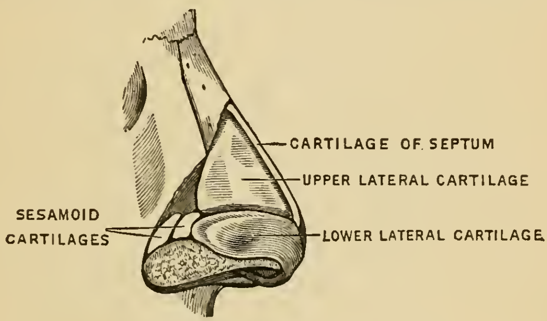


FIG. 106. — CARTILAGES OF THE NOSE.

the two nasal bones, the vomer, the septal cartilage, also by the nasal spine of the frontal, the rostrum of the sphenoid, and the crest of the maxillary and palate bones; *externally*, by the nasal process and the inner surface of the maxillary, the lachrymal, the ethmoid, the palate, the inferior turbinated bones, and the internal pterygoid plate of the sphenoid.

Meatuses of the Nose. — The outer wall of each nasal cavity is divided by the turbinated bones into three compartments — *meatuses* — of unequal size; and in these are orifices leading to air-cells — *sinuses* — in the sphenoid, ethmoid, frontal, and maxillary bones. Each of these compartments should be separately examined.

a. The *superior meatus* is the smallest of the three, and does not extend beyond the posterior half of the wall of the nose. The posterior ethmoidal and sphenoidal cells open into it. The

spheno-palatine foramen is covered by the mucous membrane, and is posterior to the meatus.

b. The *middle meatus* is larger than the superior. At its anterior part a long narrow passage (*infundibulum*), nearly hidden by a fold of membrane, leads upwards to the frontal and the anterior ethmoidal cells. About the middle a small opening leads into the antrum of the maxilla: this opening in the dry bone is large and irregular, but in the recent state it is reduced nearly to the size of a crow-quill by mucous membrane, so that a very little swelling of the membrane is sufficient to close the orifice entirely.

Notice that the orifices of the frontal and ethmoid cells are so disposed that their secretion will pass easily into the nose. But this is not the case with the maxillary cells, to empty which the head must be inclined on one side. To see all these openings the respective turbinated bones must be raised.

c. The *inferior meatus* extends nearly along the whole length of the outer wall of the nose. By raising the lower turbinated bone, we observe, towards the front of the meatus, the termination of the nasal duct, through which the tears pass down from the lachrymal sac into the nose. This sac and duct can now be conveniently examined.

Lachrymal Sac and Nasal Duct. — The lachrymal sac and nasal duct constitute the passage through which the tears are conveyed from the canaliculi into the nose (p. 49). The *lachrymal sac* occupies the groove formed by the lachrymal bone and the nasal process of the maxilla. The upper end is round and closed; the lower gradually contracts into the nasal duct, and opens into the inferior meatus. The sac is composed of a strong fibrous and elastic tissue, which adheres very closely to the bone, and is lined by mucous membrane, continuous, above, with that lining the canalicula, and below, with that of the nasal duct. Its front surface is covered by the tendo oculli and the fascia proceeding from it, and by the tensor tarsi muscle.

The *nasal duct* is from half (*13 mm.*) to three-quarters (*18 mm.*) of an inch in length, and is directed downwards, backwards, and a little outwards. Its termination is rather dilated, and is guarded by a valvular fold of mucous membrane — *valve of Hasner;* consequently, when air is blown into the nasal passages while the nostrils are closed, the lachrymal sac does not become distended. The lachrymal sac and the nasal duct are

lined with ciliated epithelium, and the canalicula with the squamous variety.

Behind the inferior turbinated bone is the opening of the Eustachian tube. Into this, as well as into the nasal duct, we ought to practise the introduction of a probe. The chief difficulty is to prevent the probe from slipping into the cul-de-sac between the tube and the back of the pharynx. (Fig. 107.)

Mucous or Schneiderian Membrane. — This membrane lines the cavities of the nose and the air-cells communicating

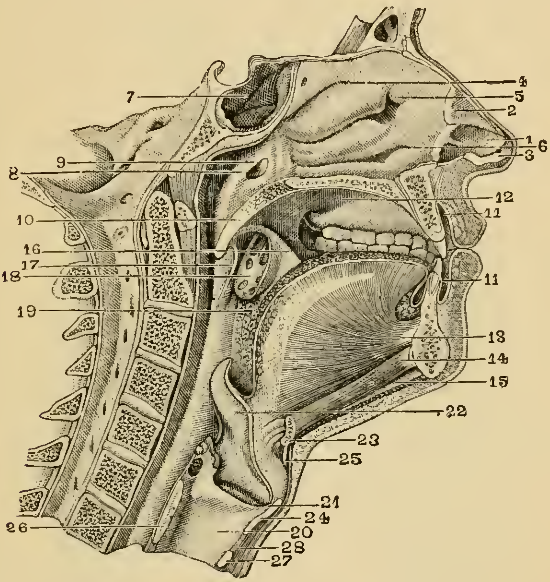


FIG. 107. — VENTRICAL SECTION OF THE NASAL FOSSÆ AND MOUTH.

1. Left nares. 2. Labial cartilage of the nose. 3. Portion of the internal alar cartilage forming the skeleton of the lower part. 4. Superior meatus. 5. Middle meatus. 6. Inferior meatus 7. Sphenoidal sinus. 8. External boundary of the posterior nares. 9. Internal elliptical opening of the Eustachian tube. 11. Soft palate.

with it, and adheres very firmly to the periosteum. Its continuity may be traced into the pharynx, into the orbits through the nasal ducts and canaliculi, into the various air sinuses — viz., the frontal, ethmoidal, sphenoidal sinuses, and the antra of Highmore, and into the tympana and mastoid cells through the Eustachian tubes. At the lower border of the turbinated bones it is disposed in thick and loose folds. The membrane varies in thickness and vascularity in different parts of the nasal cavities.

Upon the lower half of the septum and the inferior turbinated bones it is much thicker than elsewhere, owing to a fine plexus of arteries and veins in the submucous tissue. In the sinuses the mucous membrane is thinner, less vascular, and closely adherent to the periosteum.

The great vascularity of the mucous membrane raises the temperature of the inspired air, and pours out a copious secretion which prevents the membrane from becoming too dry.

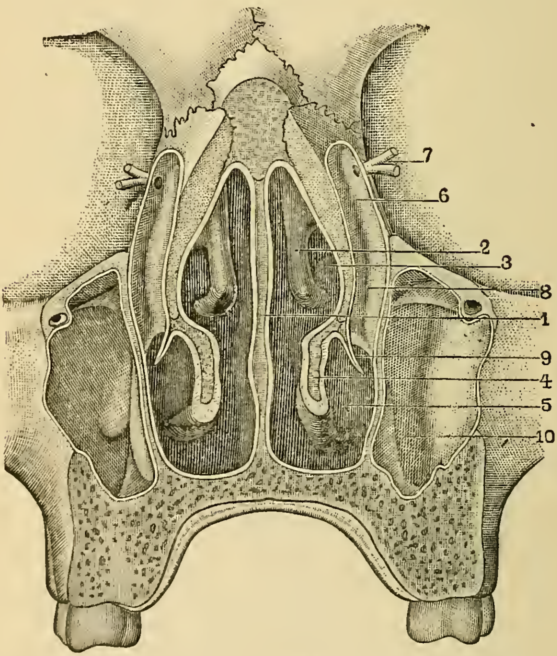


FIG. 108.—SECTION (TRANSVERSE) OF THE NASAL FOSSÆ.

1. Septum between the nasal fossæ. 2. Anterior extremity of the middle turbinated bone. 3. Middle meatus. 4. Section of the inferior turbinated bone, made on a level with the opening of the nasal canal. 5. Inferior meatus. 6. Lachrymal sac. 7. The two lachrymal canals uniting in one to open into the lachrymal sac by a common orifice. 8. Nasal canal. 9. Cut fold of mucous membrane of this canal, showing its continuance with that of the inferior meatus (Valve of Hasner). 10. Antrum of Highmore.

The mucous membrane of the nasal cavities is not lined throughout by the same kind of epithelium. Near the nostrils the mucous membrane is furnished with papillæ, with a squamous epithelium like the skin, and a few small hairs (*vibrissæ*). In the lower part of the nose — namely, along the respiratory tract and in the sinuses — the epithelium is columnar and ciliated; but in the true olfactory region — that is, upon the superior and middle turbinated bones and the upper half of the septum — the epithelium is columnar, but not ciliated. In this region the mucous membrane is extremely vascular, thick, and studded with

branched mucous glands. The columnar epithelial cells taper off at their deep ends into fine processes. Lying between these processes are fusiform cells, with central well-defined nuclei, to which the name of *olfactory cells* has been given; and it is probable that the attenuated processes which pass inwards from these cells are in direct connection with the terminal fibrils of the olfactory nerves.

The *arteries* of the nasal cavities are derived from the anterior and posterior ethmoidal branches of the ophthalmic, which supply the roof of the nose, the anterior and posterior ethmoidal cells, and the frontal sinuses; from the nasal artery of the internal maxillary, which supplies the septum, the meatuses and the turbinated bones; from the posterior dental branch of the internal maxillary, which supplies the antrum. The external nose is supplied by the nasal branch of the ophthalmic (p. 73), the arteria lateralis nasi, the angular, and the artery of the septum.

The *veins* of the nose correspond with the arteries, and, like them, form close plexuses beneath the mucous membrane. They communicate with the veins within the cranium, through the foramina in the cribriform plate of the ethmoid bone; also through the ophthalmic vein and the cavernous sinus. These communications explain the relief frequently afforded by hemorrhage from the nose in cases of cerebral congestion.

The mucous membrane of the nose is supplied with *sensory nerves* by the fifth pair. Thus, its *roof* is supplied by filaments from the external division of the nasal branch of the ophthalmic and from the Vidian; its *outer wall*, by filaments from the superior nasal branches of the spheno-palatine ganglion, from the nasal, from the inner branch of the anterior dental, and from the inferior nasal branches of the large palatine nerve; its *septum*, by the septal branch of the nasal nerve, by the nasal branches of the spheno-palatine ganglion, by the naso-palatine, and by the Vidian; its *floor*, by the naso-palatine and the inferior nasal branches of the large palatine nerve.

Olfactory Nerves. — The olfactory nerves, proceeding from each olfactory bulb, in number about twenty on each side, pass through the foramina in the cribriform plate of the ethmoid bone. In its passage each nerve is invested with a coat derived from the dura. They are arranged into an inner and an outer set. The *septal*, which are the largest, traverse the grooves in the upper third of the septum. The *outer* pass through grooves, and are divided into an anterior and a posterior group: the anterior being distributed over the superior turbinated bone, the posterior over the os planum of the ethmoid, and the middle turbinated bone is confined to the ethmoid bone.

The nerves descend obliquely between the mucous membrane and the periosteum, and break up into filaments, which communicate freely with one another, and form minute plexuses with small elongated intervals. Microscopically, the filaments differ from the other cerebral nerves in containing no white substance of Schwann, and in their axis-cylinders being provided with a very distinct nucleated sheath with fewer nuclei and at longer intervals.

DISSECTION OF THE MUSCLES OF THE BACK.

Dissection to Expose the Third Layer of Muscles. — Those muscles of the back — namely, the trapezius, latissimus dorsi, levator anguli scapulæ, and rhomboidei — which are concerned in the movements of the upper extremity will be examined in the dissection of the arm. These must be reflected near to their insertions, together with the cutaneous vessels and nerves. We now proceed to examine the three muscles forming the *third layer* of muscles, named, from their appearance, *serrati postici, superior*, and *inferior*, and the *splenius*. The nerves and arteries will be described after the dissection of the suboccipital triangle.

Serratus Posticus Superior. — This muscle is situated beneath the rhomboidei. It is a thin flat muscle, and *arises* from the lower part of the ligamentum nuchæ,* from the spinous processes of the last cervical, and two or three upper thoracic vertebræ, by a sheet-like aponeurosis which makes up nearly half the muscle; the fibres run obliquely downwards and outwards, and are *inserted* by four fleshy slips into the second, third, fourth, and fifth ribs beyond their angles. Its *action* is to raise these ribs, and therefore to assist in inspiration. Is only brought into action in forced inspiration.

Serratus Posticus Inferior. — This muscle is situated in the upper lumbar region, beneath the latissimus dorsi. It *arises* by means of the *lumbar aponeurosis*, from the spinous processes of the two last thoracic and two upper lumbar vertebræ and their supra-spinous ligament. It ascends obliquely outwards, and is *inserted* by four fleshy slips into the four lower ribs external to their angles. Its *action* is to pull down these ribs, and therefore to assist in expiration. Is only required in forced expiration, as the ordinary expiration is performed by the elasticity of the thoracic and abdominal walls and their contents. The posterior serrati muscles are supplied, respectively, by the *external* branches of the posterior divisions of the cervical and thoracic nerves.

Vertebral Aponeurosis. — The thin aponeurosis which, in

* The ligamentum nuchæ is a rudiment of the great elastic ligament of quadrupeds (termed the *pack-wax*) which supports the weight of the head. It proceeds from the spine of the occiput to the spines of all the cervical vertebræ except the atlas; otherwise it would interfere with the free rotation of the head.

the dorsal aspect of the thoracic region, separates the muscles of the upper extremity from those of the back, is called the *vertebral aponeurosis. Superiorly*, it is continued beneath the splenius, and is continuous with the deep cervical fascia; *inferiorly*, it binds down the muscles contained in the vertebral groove, and is attached to the upper border of the serratus posticus inferior, and the tendon of the latissimus dorsi; *internally*, it is attached to the spinous processes of the thoracic vertebræ, and *externally* to the angles of the ribs.

Lumbar Fascia. — This aponeurosis consists of three layers, of which only the posterior layer can now be seen, the other two being demonstrated in the dissection of the abdominal mus-

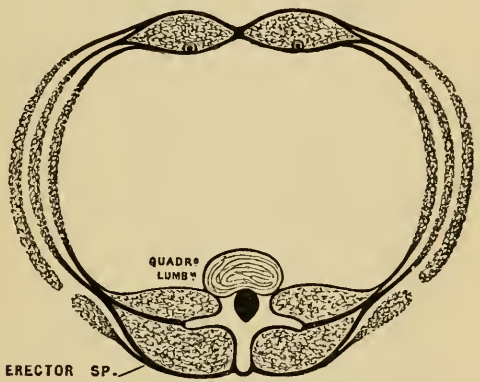


FIG. 109. — TRANSVERSE SECTION THROUGH THE ABDOMEN, TO SHOW THE ATTACHMENT OF THE THREE LAYERS OF THE LUMBAR FASCIA TO THE TRANSVERSE AND SPINOUS PROCESSES OF THE LUMBAR VERTEBRÆ.

cles. The dorsal or superficial layer is attached to the crest of the ilium, to the spinous processes of all the lower thoracic, lumbar, and sacral vertebræ; it forms a sheath for the erector spinæ, and serves for the attachment of the latissimus dorsi, the serratus posticus inferior, and the internal oblique.

The serratus posticus superior must now be reflected from its origin, and turned outwards to expose the following muscle.

Splenius.* — This muscle, so called from its resemblance to a strap, *arises* from the spinous processes of the five or six upper thoracic and the last cervical vertebræ, from the supra-

* Sometimes classified as being the fourth layer, but in reality carries out the same function in the cervical region as that performed in the lumbar region by the lumbar fascia, and hence the name applied to it, σπλήνιονεα, bandage. — A. H.

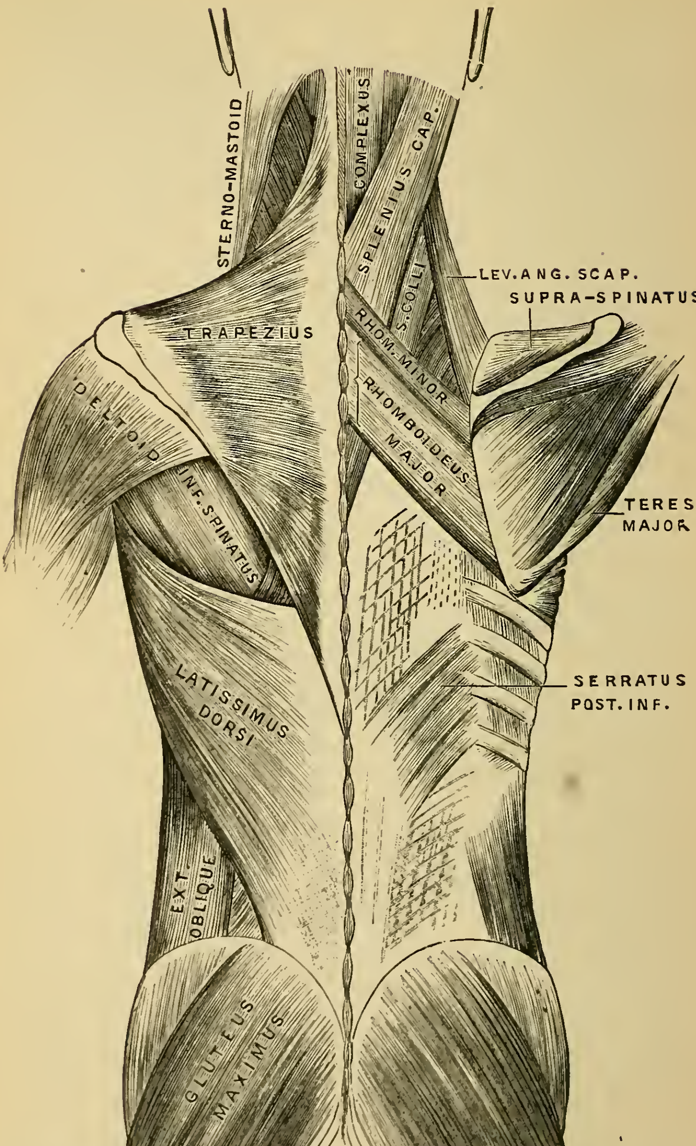


FIG. 110.—THE SUPERFICIAL MUSCLES OF THE BACK.

spinous ligament, and from the lower half o. the ligamentum nuchæ. The fleshy fibres pass upwards and outwards and divide into two portions, named, according to their respective insertions, *splenius capitis* and *splenius colli*.

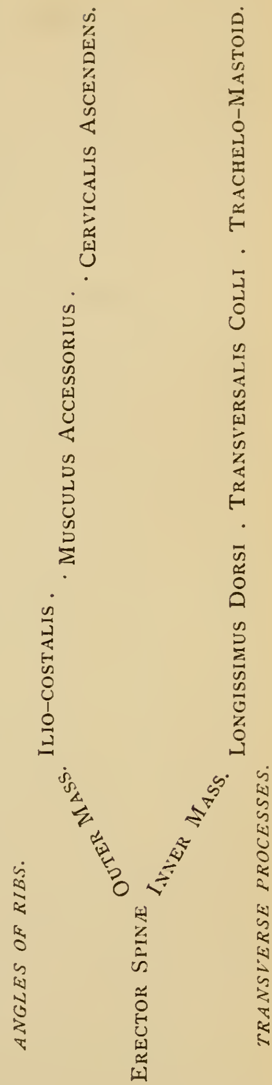
a. The *splenius capitis*, the inner of the two portions, is *inserted* into the mastoid process, and into the outer part of the superior curved line of the occipital bone, beneath the sterno-mastoid.

b. The *splenius colli*, the outer of the two portions, is *inserted* by tendinous slips into the posterior tubercles of the transverse processes of the upper three cervical vertebræ. The splenius is *supplied* by the external branches of the posterior divisions of the cervical nerves.

The *action* of the splenius, taken as a whole, is to draw the head and the upper cervical vertebræ towards its own side; so far, it co-operates with the opposite sterno-mastoid muscle. When the splenii of opposite sides contract, they extend the cervical portion of the spine, and keep the head erect. The permanent contraction of a single splenius may occasion wry-neck. It is necessary to be aware of this, otherwise one might suppose the opposite sterno-mastoid to be affected, considering that the appearance of the distortion is alike in either case.

Dissection to Expose the Fourth Layer. — To lay bare the *fourth layer* of muscles, the splenius and serratus posticus inferior are to be detached from their origins. After reflecting the vertebral aponeurosis and the lumbar fascia from its internal attachment, the erector spinæ and its prolongations are exposed.

Erector Spinæ.* — The mass of muscle which occupies the vertebral groove on each side of the spine is, collectively, called *erector spinæ*, since it counteracts the tendency of the trunk to fall for-



Arrangement of the Erector Spinæ and its Prolongations into the Posterior Thoracic and Cervical Regions.

* Sometimes described as the fifth layer of the muscles of the back.

wards. It is pointed at its lower tendinous extremity, where it arises from the sacral region; in the lumbar region it is broad, thick, and muscular; in the lower thoracic region it divides into two portions, which are continued upwards with additional muscles into the cervical vertebræ and the head. Observe that it is thickest and strongest at that part of the spine where it has the greatest weight to support — namely, in the lumbar region; and that its thickness gradually decreases towards the top of the spine.

It *arises* by thick tendinous fibres from the spinous processes of the two or three lowest thoracic and of all the lumbar vertebræ, from the spines of the sacrum, from the supra-spinous ligament, from the posterior fifth of the inner lip of the crest of the ilium, from the lower and back part of the sacrum, and from the posterior sacro-iliac ligament. From this extensive origin the muscular fibres ascend, at first as a single mass. Near the last rib, this mass divides into two: an outer, called the *ilio-costalis* or *sacro-lumbalis;* an inner, the *longissimus dorsi.* These two portions should be followed up the back; and there is no difficulty in doing so, because the division is indicated by a longitudinal groove, in which we observe the external cutaneous branches of the intercostal vessels and nerves.

Ilio–costalis or Sacro-Lumbalis. — Tracing the *ilio-costalis* or *sacro-lumbalis* upwards, we find that it terminates in a series of tendons which are *inserted* into the angles of the six lower ribs.

Musculus Accessorius ad Ilio-Costalem. — By turning outwards the ilio-costalis, we observe that it is continued upwards under the name of *musculus accessorius ad ilio-costalem.* This *arises* by a series of tendons from the angles of the six lower ribs, internal to the preceding, and is *inserted* by muscular slips into the angles of the six upper ribs.

Cervicalis Ascendens. — This is the cervical continuation of the musculus accessorius. It *arises* by tendinous slips from the angles of the four or five upper ribs, internal to the musculus accessorius, and is *inserted* into the posterior tubercles of the transverse processes of the fourth, fifth, and sixth cervical vertebræ.

Longissimus Dorsi.* — The longissimus dorsi (the inner portion of the erector spinæ) terminates in tendons which are *inserted*, internally, into the tubercles† at the root of the transverse processes of the lumbar vertebræ, into the tubercles of the articular processes of the same vertebræ, of the middle layer of the fascia lumborum, also into the transverse processes of all the thoracic vertebræ, and externally into the greater number of the ribs (varying from eight to eleven) between their tubercles and angles.

Transversalis Colli. — This is the cervical continuation of the longissimus dorsi. It *arises* by long tendinous slips from the tips of the transverse processes of the five or six upper thoracic vertebræ, and is *inserted* into the posterior tubercles of the transverse processes of the four or five lower cervical vertebræ except the last.

Trachelo-mastoid. — This muscle, situated on the inner side of the preceding, and external to the complexus, is the internal continuation of the longissimus dorsi to the cranium. It *arises* from the transverse processes of the three or four upper thoracic and the articular processes of the three or four lower cervical vertebræ, and is *inserted* by a flat tendon into the back part of the mastoid process beneath the splenius.‡

* Designated by Morris as the middle division (*Longissimus Dorsi* to and including *Trachelo-mastoid*).

† Called *anapophyses* by Professor Owen.

‡ Those who are familiar with the transcendental nomenclature of the vertebrate skeleton will understand from the following quotation the plan upon which the muscles of the back are arranged: —

"The muscles of the back are either longitudinal or oblique; that is, they either pass vertically downwards from spinous process to spinous process, from diapo-

Spinalis Dorsi.*— This is a long narrow muscle, situated close to the spines of the thoracic vertebræ, and apparently the inner part of the longissimus dorsi; it is by some considered the innermost column of the erector spinæ. It *arises* by tendinous slips from the spinous processes of the two lower thoracic and two upper lumbar vertebræ, and is *inserted* by little tendons into the spinous processes of the six or eight upper thoracic vertebræ. Beneath it is the semispinalis dorsi, which is closely connected with the spinalis dorsi.

Spinalis Colli. — This small, but *not constant muscle* corresponds in the cervical region to the spinalis dorsi in the *thoracic* region. It *arises* by tendinous slips from the spinous processes of the two or three lower cervical vertebræ (sometimes also from the two upper thoracic), and is inserted into the spine of the axis, and occasionally into the spinous processes of the third and fourth cervical.

The muscles of the spine hitherto examined are all longitudinal in their direction. We now come to a series which run obliquely from the transverse to the spinous processes of the vertebræ. And first of the complexus.

Complexus.† — This powerful muscle *arises* by tendinous slips from the transverse processes of the three or four upper thoracic and the last cervical vertebræ, also from the articular processes of four or five cervical vertebræ, and their capsular ligaments. It is *inserted* between the two curved lines of the occiput, near the vertical crest. In the centre of the muscle there is generally a transverse tendinous intersection. The muscle is perforated by the posterior branches of the second (the great occipital), third, and fourth cervical nerves. It is chiefly supplied by the great occipital nerve. Its *action* is to maintain the head erect.

Biventer Cervicis. — This muscle is placed in the inner side of the preceding muscle and frequently forms part of it. It has an intermediate tendon, and *arises* from the transverse processes of two or three upper thoracic vertebræ, and ascends

physis to diapophysis, from rib to rib (pleurapophysis), etc., or they extend obliquely from diapophysis to spine, or from diapophysis to pleurapophysis, etc.

"The erector spinæ is composed of twoplanes of longitudinal fibres aggregated together, below, to form one mass at their point of origin, from the spines and dorsal surface of the sacrum, from the sacro-iliac ligament, and from the dorsal third of the iliac crest. It divides into two portions, the sacro-lumbalis and the longissimus dorsi.

"The former, arising from the iliac crest, or from the pleurapophysis (rib) of the first sacral vertebra, is inserted by short flat tendons into (1) the apices of the stunted lumbar ribs, close to the tendinous origins of the transversalis abdominis; (2) the angles of the eight or nine inferior dorsal ribs; (3) it is inserted, through the medium of the musculus accessorius, into the angles of the remaining superior ribs, and into the long and occasionally distinct pleurapophysial element of the seventh cervical vertebra; and (4) through the medium of the cervicalis ascendens, into the pleurapophysial elements of the third, fourth, fifth, and sixth cervical vertebræ. In other words, the muscular fibres extend from rib to rib, from the sacrum to the third cervical vertebra.

"The longissimus dorsi, situated nearer the spine than the sacro-lumbalis, is inserted (1) into the metapophysial spine of the lumbar diapophyses; (2) into the diapophyses of all the thoracic vertebræ, near the origin of the levatores costarum; (3) through the medium of the transversalis colli into the diapophyses of the second, third, fourth, fifth, and sixth cervical vertebræ; and (4) through the medium of the trachelo-mastoid into the mastoid process, or the only element of a transverse process possessed by the parietal vertebra. In other words, its fibres extend from diapophysis to diapophysis, from the sacrum, upwards, to the parietal vertebra." — *Homologies of the Human Skeleton*, by H. Coote, p. 75.

* Designated by Morris as the internal division.

† Designated by Morris as the sixth layer. *Complexus*, *semispinalis dorsi*, *semispinalis colli*, *multifidus spinæ*, *obliquus capitis inferior*, *obliquus capitis superior*, *rectus capitis lateralis*.

between the ligamentum nuchæ and the complexus, to be *inserted* into the innermost depression between the two curved lines of the occipital bone.

Cut transversely through the middle of the complexus, and reflect it to see the arteria cervicalis profunda (p. 136), and the posterior branches of the cervical nerves.

Dissection to Expose the Fifth Layer. — Remove the complexus, and then turn aside the erector spinæ and its prolongations, when the *fifth layer* of muscles will be seen occupying the interval between the spinous and transverse processes.

Transverso-spinalis. — This is the mass of muscle which lies in the vertebral groove after the reflection of the complexus and the erector spinæ. It consists of a series of fibres which extend from the transverse and articular processes to the spinous processes of the thoracic and cervical vertebræ, and is for convenience divided into the *semispinalis dorsi* and *semispinalis colli.*

a. The *semispinalis dorsi arises* by long thin tendinous slips from the transverse processes of the thoracic vertebræ, from the sixth to the tenth, and is *inserted* into the spinous processes of the four upper thoracic and the two or three lower cervical vertebræ. Its *nerves* are derived from the internal posterior branches of the thoracic nerves.

b. The *semispinalis colli* lies beneath the complexus, and *arises* from the transverse processes of the five or six upper thoracic vertebræ, and the articular processes of the four lower cervical, and is *inserted* into the spinous processes of the axis and the three or four succeeding vertebræ, that into the axis being the most fleshy fasciculus. It is *supplied* by the internal posterior branches of the cervical nerves.

Now reflect part of the semispinalis dorsi in order to expose the multifidus spinæ.

Multifidus Spinæ. — This may be considered a part of the preceding muscle, since its fixed points and the direction of its fibres are the same. It consists of a series of little muscles which extend between the spinous and transverse processes of the vertebræ, from the sacrum to the second cervical vertebræ. Those in the lumbar region are the largest. In the sacral region the fibres *arise* from the dorsum of the sacrum as low down as the fourth foramen, from the deep surface of the aponeurosis of the erector spinæ, from the inner part of the posterior superior iliac spine, and from the posterior sacro-iliac ligament; in the lumbar region, from the mammillary processes on the superior articular processes; in the thoracic region, from the transverse processes, and in the cervical region from the articular processes of the four lower cervical vertebræ. They all ascend obliquely, and each fasciculus is *inserted* into the lamina and spinous process of the vertebra above, except the atlas. It should be observed that their fibres are not of uniform length; some extend only from vertebra to vertebra, while others extend between one, two, or even three vertebræ. It is *supplied* by the internal posterior branches of the sacral, lumbar, thoracic, and cervical nerves.

Rotatores Spinæ. — Beneath the multifidus spinæ, in the thoracic region of the spine only, are eleven flat and somewhat square muscles, called *rotatores spinæ.* They *arise* from the upper and back part of the transverse processes, and are *inserted* into the lower border of the laminæ of the vertebra above. These muscles form but a part of the multifidus spinæ, and are *supplied* by the internal posterior branches of the thoracic nerves.

The *action* of the preceding muscles is not only to assist in maintaining the trunk erect, but to incline and rotate the spine to one or the other side.

Levatores Costarum. — These small muscles, twelve in number, on each side, *arise* from the apices of the transverse processes of the seventh cervical and the eleventh upper thoracic vertebræ, and are *inserted* into the rib below. The direction of their fibres corresponds with that of the outer layer of the intercostal muscles, and they are *supplied* by the internal posterior branches of the thoracic nerves. They are muscles of inspiration.

Supraspinales. — These are formed by a series of small muscular slips lying over the spinous processes of the cervical vertebræ. Their *nerves* are derived from the internal posterior branches of the cervical nerves.

Inter-spinales. — These muscles extend between the spinous processes of the contiguous vertebræ. They are arranged in pairs, and only exist in those parts of the vertebral column which are most movable. In the cervical region they are the most distinct and pass between the spinous processes of the six lower cervical vertebræ. In the thoracic they are found between the spinous processes of the first and second, and between those of the eleventh and twelfth thoracic vertebræ. They are also found more or less distinctly between the spinous processes of the lumbar vertebræ. They are supplied by the internal posterior branches of the spinal nerves.

Inter-transversales. — These muscles extend between the transverse processes of the vertebræ. In the *cervical region* they are seven in number, and are most marked, being arranged in pairs, and extend between the anterior and posterior tubercles of contiguous vertebræ. The anterior branch of the corresponding cervical nerve separates the two fasciculi. In the *thoracic region* these muscles in the upper part are represented by small round tendons, but in the three lower thoracic vertebræ they again become muscular in structure. In the *lumbar region* the muscular fasciculi are four in number, and are also arranged in pairs between the transverse processes. Their *nerve-supply* is derived from the internal posterior branches of the cervical, thoracic, and lumbar nerves.

We have next to examine the muscles concerned in the movement of the head upon the first and second cervical vertebræ (Fig. 111).

Rectus Capitis Posticus Major. — This is a largely developed interspinal muscle. It *arises* by a small tendon from the well-marked spinous process of the second cervical vertebra, and, expanding considerably, is *inserted* into the inferior curved ridge of the occipital bone, and into the surface of the bone below it. These recti muscles, as they ascend, one on each side, to their insertions, diverge and leave an interval between them in which are found the recti capitis postici minores.

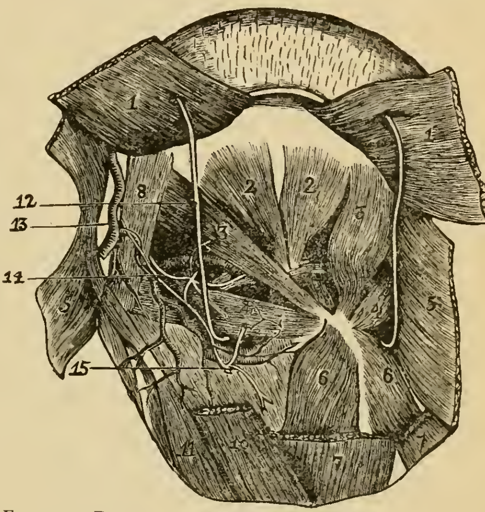


FIG. 111. — DRAWING FROM NATURE, OF THE SUBOCCIPITAL TRIANGLE.

1 and 7. Complexus. 2. Rectus cap. posticus minor. 3. Rectus cap. posticus major. 4. Obliquus inferior. 5. Sterno-mastoid. 6. Semispinalis colli. 8. Obliquus superior. 10. Splenius. 11. Trachelo-mastoid. 12. Great occipital nerve. 13. Occipital artery giving off its descending branch — the *princeps cervicis*. 14. Suboccipital nerve. 15. Third cervical nerve (posterior branch).

Rectus Capitis Posticus Minor. — This is an interspinal muscle, but smaller than the preceding. *Arising* from the posterior tubercle of the first vertebra, it expands as it ascends, and is *inserted* into the occipital bone between the inferior curved ridge and the foramen magnum. The *action* of the two preceding muscles is to raise the head. They are supplied with *nerves* from the posterior branch of the suboccipital.

Obliquus Inferior. — This *arises* from the spinous process of the second cervical vertebra, and is *inserted* into the transverse process of the first. Its *action* is to rotate the first upon the second vertebra; in other words, to turn the head round to the same side. It is supplied with a *nerve* by the great occipital (posterior division of the second cervical), which curves up under its lower border.

Obliquus Superior. — This muscle *arises* from the transverse process of the atlas, and, ascending obliquely inwards, is *inserted* in the interval between the curved ridges of the occipital bone. Its *action* is to draw the occiput towards the spine.

Suboccipital Triangle. — Observe that the obliqui (superior and inferior) and the rectus capitis posticus major form what is called the *suboccipital triangle*. The outer side is formed by the obliquus superior; the inner, by the rectus capitis posticus major; the lower, by the obliquus inferior. Within this triangle may be seen the arch of the atlas, the vertebral artery lying in a groove on its upper surface, and the posterior occipito-atloid ligament. Between the artery and the bone appears the posterior division of the suboccipital nerve, which here sends branches to the recti postici, the obliqui, and the complexus; that is to say, it supplies the muscles which form the triangle, and the complexus that covers it.

Rectus Capitis Lateralis. — This small muscle *extends* between the transverse process of the first vertebra and the eminentia jugularis of the occiput; but, since this eminence is the transverse process of the occipital vertebra, the muscle should be considered as an intertransverse one. Its *nerves* come from the anterior division of the suboccipital.

Nerves of the Back. — The posterior branches of the spinal nerves supply the muscles and skin of the back. They pass backwards between the transverse processes of the vertebræ, and divide into *external* and *internal* branches. The general plan upon which these nerves are arranged is the same throughout the whole length of the spine; but, since there are certain peculiarities deserving of notice in particular situations, we must examine each region separately.

Cervical Region. — The posterior division of the *first cervical nerve* (the suboccipital) passes between the arch of the atlas and the vertebral artery; it then enters the suboccipital triangle, and divides into branches which supply the muscles; one, which passes downwards to supply the inferior oblique, and also sends downwards a branch to communicate with the second cervical nerve; another passes upwards to supply the recti capitis major and minor; another supplies the obliquus superior; another enters the complexus; and, lastly, a cutaneous branch is sometimes given off which accompanies the occipital artery, and is distributed to the back of the scalp.

The posterior branch (the great occipital) of the *second cervical nerve* is the largest of the series, and emerges between the arches of the atlas and axis. It turns upwards beneath the inferior oblique muscle, passes through the complexus, and runs with the occipital artery to the back of the scalp.

The posterior divisions of the six lower cervical nerves divide into *external* and *internal* branches. The *external* are small, and terminate in the splenius, and the continuation of the erector spinæ — viz., the trachelo-mastoid, the transversalis colli, and the cervicalis ascendens. The *internal*, by far the larger, proceed towards the spinous processes of the vertebræ; those of the third, fourth, and fifth lie between the complexus and the semispinalis,* and after supplying the muscles terminate in the skin over the trapezius; those of the sixth, seventh, and eighth lie between the semispinalis and the multifidus spinæ, to which they are distributed, and do not as a rule give off any cutaneous branches.

Thoracic Region. — The posterior divisions of the spinal nerves in this region come out between the transverse processes and the tendons attached to them. They soon divide into *external* and *internal* branches. The *external* pass obliquely over the levatores costarum, between the ilio-costalis and the longissimus dorsi, and successively increase in size from above downwards. The upper six terminate in the erector spinæ and the levatores costarum; the lower six, after supplying these muscles, pass through the latissimus dorsi, and become the cutaneous nerves of the back. The *internal* successively decrease in size from above downwards.

* The posterior branches of the second, third, and fourth nerves are generally connected, beneath the complexus, by branches in the form of loops. This constitutes the *posterior cervical plexus* of some other anatomists.

a, *a*, Small occipital nerve from the cervical plexus; 1, external muscular branches of the first cervical nerve and union by a loop with the second; 2, the rectus capitis posticus major, with the great occipital nerve passing round the short muscles and piercing the complexus; the external branch is seen to the outside; $2'$, the great occipital; 3, external branch of the posterior primary division of the third nerve; $3'$, its internal branch, or third occipital nerve; $4'$, $5'$, $6'$, $7'$, $8'$, internal branches of the several corresponding nerves on the left side; the external branches of these nerves proceeding to muscles are displayed on the right side: *d* 1 to *d* 6, and thence to *d* 12, external muscular branches of the posterior primary divisions of the twelve thoracic nerves on the right side; *d* $1'$, to *d* $6'$, the internal cutaneous branches of the six upper thoracic nerves on the left side; *d* $7'$ to *d* $12'$, cutaneous branches of the six lower thoracic nerves from the external branches; *l*, *l*, external branches of the posterior primary branches of several lumbar nerves on the right side piercing the muscles, the lower descending over the gluteal region; l', l', the same more superficially on the left side; *s*, *s*, on the right side, the issue and union by loops of the posterior primary divisions of four sacral nerves, s', s', some of these distributed to the skin on the left side.

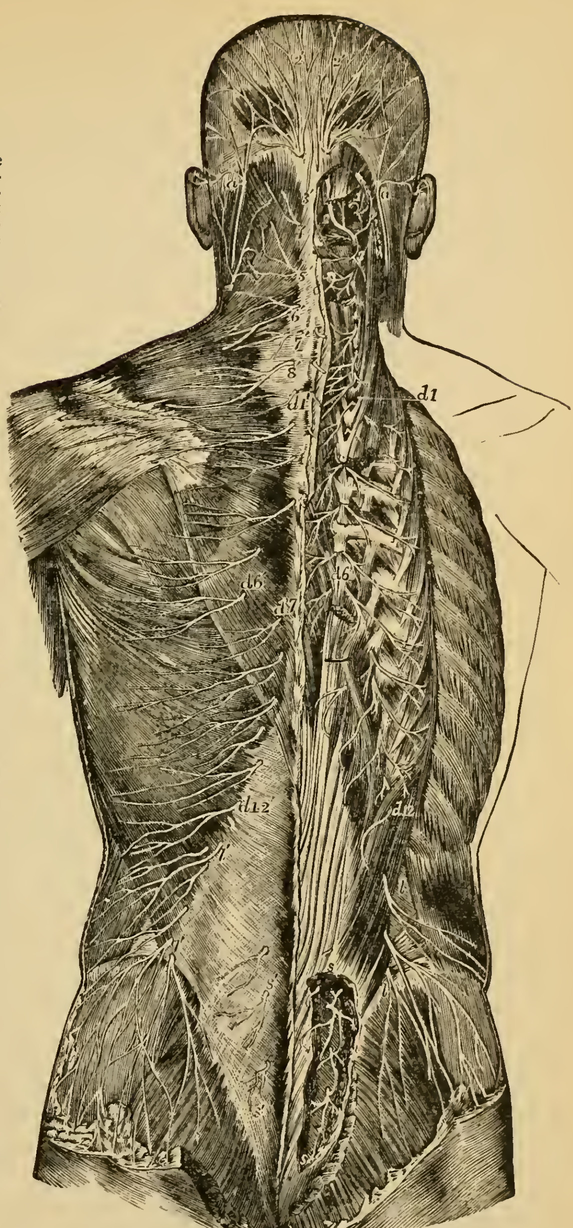


FIG. 112.—DIAGRAM OF THE CUTANEOUS NERVES OF THE BACK.

They run towards the spine between the semispinalis dorsi and the multifidus spinæ. The upper six, after giving branches to the muscles, perforate the trapezius and become cutaneous nerves. The lower ones terminate in the muscles of the vertebral groove.

Lumbar Region. — The general arrangement of the nerves in this region resembles that of the thoracic. Their *external* branches, after supplying the erector spinæ, become cutaneous, and terminate in the skin over the buttock. The *internal* branches supply the multifidus spinæ.

Sacral Region. — The posterior divisions of the spinal nerves in this region are small. With the exception of the last, they come out of the spinal canal through the foramina in the back of the sacrum. The upper two or three divide into *external* and *internal* branches. The *internal* terminate in the multifidus spinæ; the *external* become cutaneous and supply the skin of the gluteal region. The last two sacral nerves proceed, without dividing, to the integument.

The Coccygeal nerve is exceedingly small, and, after joining a small branch from the last sacral, terminates in the skin over the coccyx.

Arteries of the Back. — The arteries which supply the back are: 1. Small branches from the occipital; 2. Small branches from the vertebral; 3. The deep cervical; 4. The posterior branches of the intercostal and lumbar arteries.

The *occipital artery* furnishes several small branches to the muscles at the back of the neck; one, larger than the rest, the *arteria princeps cervicis*, descends beneath the complexus, and generally inosculates with the deep cervical artery, and with small branches from the vertebral.

The *vertebral artery* runs along the groove in the arch of the atlas, and before perforating the posterior occipito-atloid ligament to enter the skull, distributes small branches to the adjacent muscles.

The *deep cervical artery* is the posterior branch of the first intercostal artery (from the subclavian). It passes backwards between the transverse process of the last cervical vertebra and the first rib; it then ascends between the complexus and the semispinalis colli, and anastomoses with the princeps cervicis.

The *posterior* branches of the intercostal and lumbar arteries accompany the corresponding nerves, and are in all respects similar to them in distribution. Each sends a small branch into the spinal canal (*intraspinal*), and small branches to the vertebra.

The *veins* correspond to the arteries.

Prevertebral Muscles. — We have, lastly, to examine three muscles, situated in front of the spine: namely, the longus colli, the rectus capitis anticus major, and the rectus capitis anticus minor. In order to have a complete view of the two latter, a special dissection should be made, before the head is removed from the first vertebra.

Longus Colli. — This muscle is situated in front of the spine, and extends from the third thoracic vertebra to the atlas. For convenience of description it is divided into three sets of fibres, of which one extends *longitudinally* from the body of one vertebra to that of another; the two others extend *obliquely* between the transverse processes and the bodies of the vertebræ.

The *longitudinal* portion of the muscle *arises* from the bodies of the three upper thoracic and the three lower cervical vertebræ, and is *inserted* into the bodies of the second, third, and fourth cervical vertebræ.

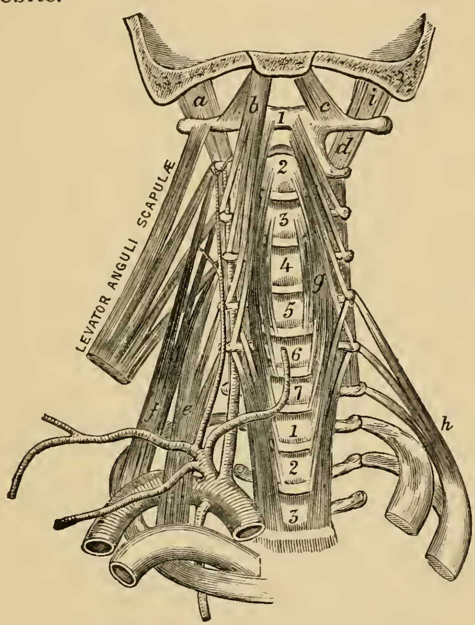


Fig. 113. — Diagram of the Prevertebral Muscles.

1–7. The bodies of the cervical vertebræ: below are the bodies of the three upper thoracic vertebræ. *a.* Rectus capitis lateralis. *b.* Rectus capitis anticus major. *c.* Rectus capitis anticus minor. *d.* Intertransverse muscle. *e.* Scalenus anticus. *f.* Scalenus medius. *g.* Longus colli. *h.* Scalenus posticus.

The *superior oblique* portion, *arising* from the anterior tubercles of the transverse processes of the third, fourth, and fifth cervical vertebræ, ascends inwards, and is *inserted* into the front part or body of the atlas. The *inferior oblique* portion proceeds from the bodies of the three upper thoracic vertebræ, and passing upwards and outwards, is *inserted* into the transverse processes of the fifth and sixth cervical vertebræ. The *action* of

this muscle, taken as a whole, must be to bend the cervical region of the spine. Its *nerves* come from the lower cervical nerves.

Rectus Capitis Anticus Major. — This muscle *arises* by tendinous slips from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ, and, ascending obliquely inwards, is *inserted* into the basilar process of the occipital bone, in front of the foramen magnum.

Rectus Capitis Anticus Minor. — This muscle *arises* from the front of the root of the transverse process of the atlas, and is *inserted* into the basilar process of the occipital bone, nearer to the foramen magnum than the preceding muscle. The *action* of the recti muscles is to bend the head forwards. They are supplied with *nerves* from the anterior division of the suboccipital, and from the deep cervical plexus.

LIGAMENTS OF THE SPINE.

The vertebræ are connected by their intervertebral fibro-cartilages, by ligaments in front of and behind their bodies, and by ligaments which extend between their arches and their spines. Their articular processes have capsular ligaments and synovial membranes.

Anterior Common Ligament. — This is a strong, broad band of longitudinal fibres which extends along the front of the bodies of the vertebræ from the occipital bone to the sacrum. The ligament is broader below than above, thickest in the thoracic region, and its fibres are more firmly adherent to the intervertebral cartilages and to the borders of the vertebræ than to the middle of the bones. The fibres are not all of equal length; the more superficial extend from one vertebra to the fourth or fifth below it; those a little deeper pass from one vertebra to the second or third below it, while the deepest of all proceed from vertebra to vertebra. Above, it is attached to the axis by a pointed process, where it is connected with the longus colli, and it is thicker over the bodies of the vertebra than over the intervertebral cartilages, thus filling up the concavities of the bodies and rendering the surface more smooth and even.*

Posterior Common Ligament. — This extends longitudinally, in a similar manner to the anterior common ligament,

* The student should remember that the anterior and posterior common ligaments are in reality continuous, and also that the deeper portions of these ligaments form firm attachments for the disks of cartilage. — A. H.

within the spinal canal, along the posterior surface of the bodies of the vertebræ, from the occipital bone to the sacrum. It is broader above than below, and, like the anterior ligament, is thickest in the thoracic region, and is more intimately connected with the intervertebral fibro-cartilages than with the bodies of the vertebræ. It sends up a prolongation to the anterior border of the foramen magnum continuous with the apparatus ligamentosus.

Interspinous Ligaments. — These bands of ligamentous fibres fill up the intervals between the spines of the thoracic and lumbar vertebræ. They are most marked in the lumbar region.*

Supraspinous Ligament. — Those fibres which connect the apices of the spines, being stronger than the rest, are described as a separate ligament under the name of *supraspinous*. It extends from the spinous process of the seventh cervical to the spine of the sacrum, and is strongest in the lumbar region. Their use is to limit the flexion of the spine.

Ligaments between the Arches of the Vertebræ. — These are called, on account of their color, *ligamenta subflava.* To obtain a good view of them the arches of the vertebræ should be removed with a saw, and the ligaments should be seen from within, since viewed from without they are to a large extent hidden by the overlapping laminæ. They pass between the laminæ of the contiguous vertebræ from the axis to the sacrum; none existing between the occiput and the atlas, or between the atlas and the axis. Each ligament consists of two halves which are attached to the corresponding half laminæ above and below on each side. They are composed of yellow elastic tissue, the fibres being arranged vertically, and their strength increases with the size of the vertebræ. This elasticity answers a double purpose; it not only permits the spine to bend forwards, but materially assists in restoring it to its *curve of rest.* They economize muscular force, like the ligamentum nuchæ in animals.

Intervertebral Fibro-cartilage. — This substance, placed between the bodies of the vertebræ, is by far the strongest bond of connection between them, and fulfils most important purposes in the mechanism of the spine. Its peculiar structure is adapted to break shocks and to render the spine flexible and resilient. To see the structure of an intervertebral fibro-cartilage, a horizontal section must be made through it. It is firm

* The interspinous ligaments are replaced in the cervical region by the interspinales muscles. — A. H.

and resisting near the circumference, but soft and pulpy towards the centre. The circumferential portion is composed of concentric layers of fibro-cartilage, placed vertically. These layers are attached by their edges to the vertebræ; they gradually decrease in number from the circumference towards the centre; and the interstices between them are filled by soft pulpy tissue. The central portion is composed almost entirely of this pulpy tissue, and it bulges when no longer under pressure. Thus the bodies of the vertebræ, in their motions upon each other, revolve upon an elastic cushion tightly girt all round by bands of fibrous tissue. These motions are regulated by the articular processes.

Dissect an intervertebral substance layer after layer in front, and you will find that the circumferential fibres extend *obliquely* between the vertebræ, crossing each other like the branches of the letter X (Fig. 116, p. 303).

The thickness of the intervertebral cartilages is not the same in front and behind. It is this difference in their thickness, more than that in the bodies of the vertebræ, which produces the several curves of the spine. In the lumbar and cervical regions they are thicker in front; in the thoracic region, behind.

The structure of the intervertebral cartilages explains the well-known fact that a man becomes shorter after standing for some hours, and that he regains his usual height after rest. The difference between the morning and evening stature amounts to more than half an inch (*13 mm.*).

It also explains the fact that a permanent lateral curvature of the spine may be produced (especially in the young) by the habitual practice of leaning to this or that side. Experience proves that the cause of lateral curvature depends more frequently upon some alteration in the structure of the fibro-cartilages than upon the bones. From an examination of the bodies of one hundred and thirty-four individuals with crooked spines, it was concluded that, in two-thirds, the bones were perfectly healthy; that the most frequent cause of curvature resided in the intervertebral substances, these being, on the concave side of the curve, almost absorbed, and, on the convex side, preternaturally developed. As might be expected in these cases, the muscles on the convex side become lengthened, and degenerate in structure.*

* On this subject see Hildebrandt's *Anatomie*, B. ii, s. 155. The aggregation of the vertebral disks is one-fourth the total length of the column, and changes the direction of its curves. This is most marked in the aged, when a concavity

Ligamentum Nuchæ. — This ligament is a thin, triangular, fibrous septum, intermingled with elastic tissue, situated in the middle line, and extends from the spinous processes of the seventh cervical vertebræ to the chest and external occipital protuberance. It forms an intermuscular septum down the back of the neck, and may be regarded as the continuation upwards of the supraspinous ligament.

Capsular Ligaments. — Each joint between the articular processes has a synovial membrane surrounded by loose ligamentous fibres, forming a capsular ligament which is longest in the cervical vertebræ, thus allowing free movement in this region. The surfaces of the bones are crusted with cartilage.

Intertransverse Ligaments. — These are thin bands of fibres which pass between the transverse processes of the vertebræ. They are rudimentary in the cervical region, and are sometimes absent.*

Movements of the Spine. — Though but little movement is permitted between any two vertebræ (the atlas and axis excepted), yet the collective motion between them all is considerable. The spine can be bent forwards, backwards, or on either side; it also admits of slight rotation. In consequence of the elasticity of the intervertebral cartilages and the ligamenta subflava, it returns spontaneously to its natural curve of rest like an elastic bow. Its mobility is greatest in the cervical region, on account of the thickness of the fibro-cartilages, the small size of the vertebræ, the oblique direction of their articulations, and, above all, the horizontal position and the shortness of their spines. In the thoracic region there is very little mobility, on account of the vertical direction of the articular processes, and the manner in which the arches and the spines overlap each other. In the lumbar region, the spine again becomes more movable, on account of the thickness of the intervertebral cartilages, and the horizontal direction of the spinous processes.

Ligaments between the Occipital Bone and the Atlas. — The occiput is connected to the atlas by the following ligaments: viz., two anterior occipito-atloid, or *occipito-atlantal*, a posterior occipito-atloid, or *occipito-atlantal*, two lateral occipito-atloid, or *occipito-atlantal*, and two capsular ligaments.

may exist below the centre of the thoracic region, due to the absorption of the anterior or ventral portion of the disk from pressure, according to the occupation or habit of the individual. — A. H.

* In the cervical region these ligaments are replaced by intertransversales muscles, and can only be well demonstrated in the lumbar region. — A. H.

The *two anterior* or *occipito-atlantal ligaments* * are composed of a superficial and a deep portion; the *superficial* part is a strong rounded cord which passes from the basilar process above, to the tubercle on the anterior arch of the atlas below; the *deep* portion is membranous, and passes from the anterior margin of the foramen magnum to the front arch of the atlas.

The *posterior occipito-atlantal ligament* extends in a similar manner from the posterior border of the foramen magnum to the posterior arch of the atlas. It is thin, and superiorly becomes blended with the dura, and is pierced by the vertebral artery and the suboccipital nerve.

The *two lateral occipito-atlantal ligaments* pass from the jugular eminences of the occiput downwards and outwards to the transverse processes of the atlas.

The *capsular occipito-atlantal ligaments* extend from the margin of the condyles of the occipital bone to the upper articular borders of the atlas.

The movements which take place between the occipital bone and the atlas are flexion and extension, as in nodding forwards and backwards; and lateral movement, as in inclining the head sideways.

Ligaments between the Occipital Bone and the Axis.— These are the most important; and to see them, make a vertical transverse section through the occipital bone in the posterior third of the foramen magnum, dividing the pedicles near the bodies of the cervical vertebræ. The superficial portion of the posterior common vertebral ligament must then be removed, exhibiting the *occipito-cervical ligament,* i. e., the deeper portion of the posterior common vertebral ligament which extends from the dorsal or posterior surface of the third vertebra to the basilar groove of the occipital bone; the *crucial,* the vertical portion of the *transverse ligament* holding the odontoid process in contact with the atlas, passing from the base of the odontoid process to the basilar surface of the foramen magnum. It is difficult often to make this dissection because of the intimate relation of the occipito-cervical ligament. (A. H.) It is called the *occipito-axial ligament,* or the *apparatus ligamentosus colli.*

Odontoid or Check Ligaments.—The *odontoid* or *check ligaments* (Fig. 114) are two very strong ligaments, which proceed from the sides of the odontoid process to the tubercles on the inner sides of the condyles of the occiput. Their use is to

* These ligaments are by some authors described as one.—A. H.

limit the rotation of the head. A *third* or *middle odontoid ligament* passes from the apex of the odontoid process to the margin of the foramen magnum. It is sometimes called the *ligamentum supensorium.*

Articulation Between the Atlas and the Axis. — This joint forms a lateral ginglymus or diarthrosis rotatoria, and is maintained by the following ligaments: two anterior atlo-axial, a posterior atlo-axial, two capsular, and a transverse.

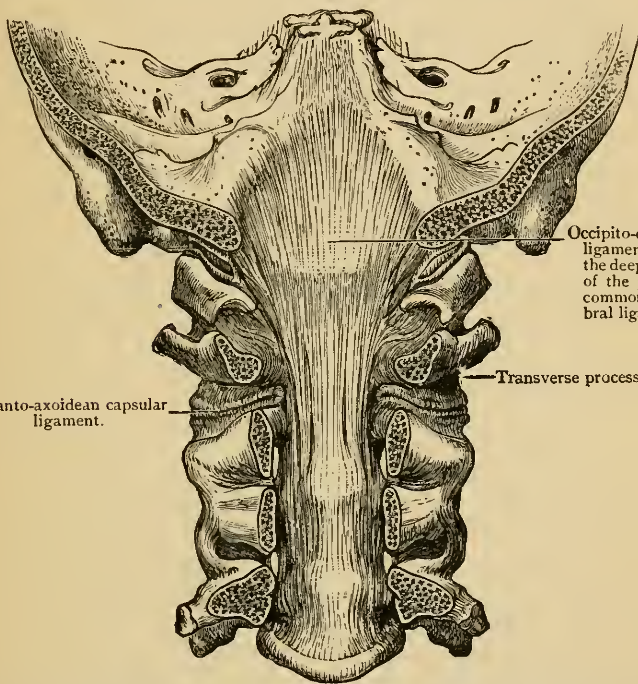


FIG. 114. — THE SUPERFICIAL LAYER OF THE POSTERIOR COMMON VERTEBRAL LIGAMENT HAS BEEN REMOVED TO SHOW ITS DEEP OR SHORT FIBRES. THESE DEEP FIBRES FORM THE OCCIPITO-CERVICAL LIGAMENT. (MORRIS.)

The *two anterior atlanto-axoidean ligaments* * consist of a superficial and a deep portion : the *superficial* is a rounded ligament passing from the tubercle of the atlas to the base of the odontoid process ; the *deep* passes as a membranous layer from the anterior arch of the atlas to the body of the axis.

* These ligaments are often described as one. — A. H.

The *posterior atlanto-axoidean ligament* extends from the posterior arch of the atlas to the upper border of the lamina of the axis.

The *two lateral capsular ligaments* are thin, loose, ligamentous sacs connecting the borders of the articular surfaces.

The *transverse ligament* (Fig. 115) passes transversely behind the odontoid process and is attached to the tubercles on the

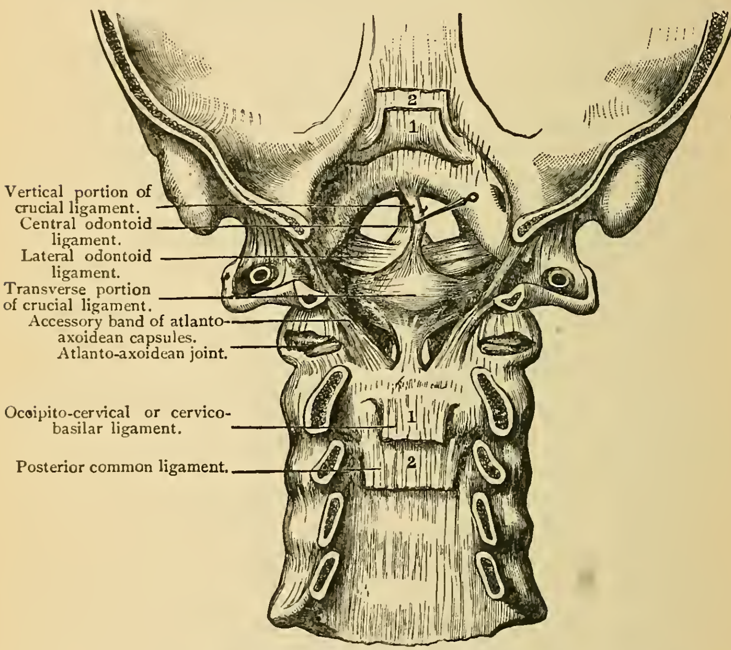


FIG. 115.—VERTICAL TRANSVERSE SECTION OF THE SPINAL COLUMN AND THE OCCIPITAL BONE TO SHOW LIGAMENTS. (MORRIS.)

inner sides of the articular processes of the atlas. From the centre of this ligament a few fibres pass upwards, to be attached to the basilar process, and some downwards to the body of the axis, giving it a cruciform appearance. Thus it forms with the atlas a ring, into which the odontoid process is received. If this transverse ligament be divided, we observe that the odontoid process is covered with cartilage in front and behind, and is provided with two (*atlanto-odontoid capsular ligaments*) synovial membranes.

The ribs articulate by their heads with the bodies of the thoracic vertebræ; by their necks and tubercles with the transverse processes of the vertebræ, and by their cartilages with the sternum in front.

Articulations of the Heads of the Ribs with the Bodies of the Vertebræ. — The head of each rib presents two articular surfaces, corresponding to the bodies of two vertebræ. There are two distinct articulations, each provided with a separate synovial membrane. The ligaments are —

1. An *anterior costo-central* or *stellate*, which connects the front of the head of the rib with the sides of the bodies of two vertebræ and the intervening fibro-cartilage (Fig. 116). It is composed of three fasciculi of fibres which radiate from the rib, one of which passes upwards to be attached to the body of the

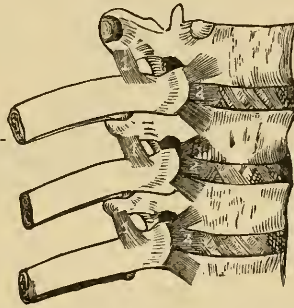


FIG. 116. — COSTO-VERTEBRAL LIGAMENTS.

vertebra above; the lower one passes to the body of the vertebra below; while the intermediate one passes horizontally forward to the intervertebral disk.

In the three lower ribs the fasciculi are not separately distinguishable, although the fibres pass upwards to the vertebræ and downwards to the vertebra with which the rib articulates.

Some anatomists describe a *capsular ligament* surrounding the articulation; the fibres are very thin, and form part of the costo-central ligament.

2. An *interarticular ligament* which passes across the joint from the ridge on the head of the rib to the intervertebral cartilage. It divides the articulation into two joints which do not communicate with each other. It is absent in the three lower articulations.

Articulations of the Neck and Tubercle of the Ribs with the Transverse Processes. — The ligaments connecting these

bones are the capsular, the anterior, middle, and posterior costo-transverse.

The *capsular ligament* surrounds the articular surfaces of the tubercle of the rib and the transverse process of its corresponding vertebra, and has a synovial membrane. It is absent in the eleventh and twelfth ribs.

The *ventral* or *superior costo-transverse ligament* ascends from the upper border of the neck of the rib to the lower border of the transverse process above it. It is continuous externally with the aponeurosis covering the external intercostal muscle. The first and twelfth ribs have no anterior costo-transverse ligament (Fig. 116).

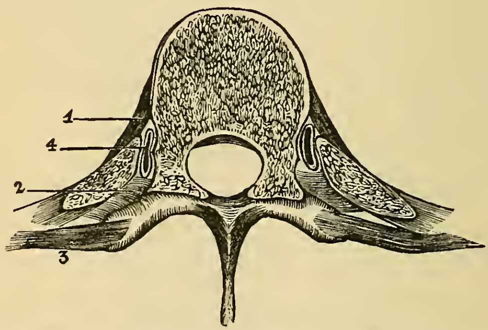


FIG. 117.—DIAGRAM SHOWING THE LIGAMENTS CONNECTING THE RIB WITH THE VERTEBRA. 1. The anterior costo-central ligament. 2. The interosseous, or middle costo-transverse ligament. 3. The posterior costo-transverse ligament. 4. The synovial membrane between the rib and the body of the vertebra.

The *middle costo-transverse ligament* is an interosseous one, and connects the adjacent surfaces of the neck of the rib, and the transverse process. It is badly developed in the eleventh and twelfth ribs (Fig. 117).

The *dorsal costo-transverse ligament* passes from the apex of the transverse process to the summit of the tubercle of the rib. It is wanting in the eleventh and twelfth ribs (Fig. 117).

Connection Between the Cartilages of the Ribs and Sternum.—The ventral extremities of the ribs are concave, and receive the cartilages of the ribs; this junction is maintained by the periosteum. The cartilages of all the true ribs are received into slight concavities on the side of the sternum, and are secured by *anterior*, *posterior*, *upper*, and *lower ligaments*. There is a synovial membrane between the cartilage of each rib and the sternum, except that of the first, and usually at each

articulation the synovial membrane is separated into two by an interarticular ligament.

The *costal cartilages from the sixth to the tenth* are connected by ligamentous fibres. There are intercostal synovial membranes in front between the adjacent borders of the sixth, seventh, eighth, and ninth costal cartilages.

Movements of the Ribs. — The movements permitted between the heads of the ribs and the bodies of the vertebræ are those of elevation and depression, and those of rotation forwards and backwards; the centre of these movements being at the interarticular ligament. Between the tubercles and the trans-

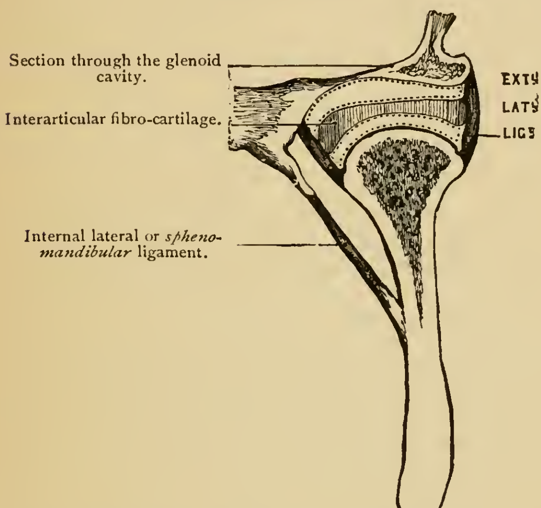


FIG. 118.—TRANSVERSE SECTION TO SHOW THE LIGAMENTS AND THE FIBRO-CARTILAGE OF THE TEMPERO-MANDIBULAR JOINT. THE DOTTED LINES REPRESENT THE TWO SYNOVIAL MEMBRANES.

verse processes there is the movement of an arthroidal nature, and between the costal cartilages and the sternum that of elevation and depression.

The movement of the first rib is very slight; that of the second is freer; and mobility of the ribs gradually increases from above downwards.

Articulation of the Mandible. — The condyle of the mandible articulates with the glenoid cavity of the temporal bone, and forms an arthroidal joint. The joint is provided with an interarticular fibro-cartilage, with external and internal lateral and capsular ligaments, and two synovial membranes (Fig. 118).

The *external lateral tempero-mandibular ligament* is the thickest portion of the capsule, extending from the zygoma and its tubercle ; its fibres pass downwards and backwards to the outer surface and posterior border of the neck of the mandible.

The *internal lateral* or *spheno-mandibular ligament* — a long, thin, flat band — extends from the spinous process of the sphenoid bone to the inner border of the dental foramen. This ligament therefore differs from the external ligament in that it has no connection with the capsule. It should always be remembered that the mandibular artery is between the internal lateral or spheno-mandibular and the mesial portion of the capsule. — A. H.

The *capsular ligament* consists of a few scattered fibres attached above to the margin of the glenoid cavity, below to the neck of the mandible.

The *interarticular fibro-cartilage* is a thin plate of an oval form, and thicker at the margin than at the centre. It is placed horizontally, and its upper surface is concavo-convex from before backwards ; its lower surface is concave. It is connected on the outer side to the external lateral ligament, and on the inner side some of the fibres of the external pterygoid muscle are inserted into it.

There are two *synovial membranes* — an upper and a lower — for the joint. The larger and looser of the two is situated between the glenoid cavity and the fibro-cartilage. The lower is interposed between the fibro-cartilage and the condyle of the mandible. They sometimes communicate through a small aperture in the centre of the fibro-cartilage.

The form of the articulation of the mandible admits of movement upwards and downwards, forwards, backwards, and from side to side. A combination of these movements takes place in mastication ; during this act the condyles of the mandible describe an oblique rotary movement in the glenoid cavity. The purposes served by the fibro-cartilage in this joint are : first, it follows the condyle, and interposes a convenient socket for all its movements ; second, being elastic, it breaks shocks ; for shocks here would be almost fatal, considering what a thin plate of bone the glenoid cavity is, and that just above it is the brain. Its *nerves* are derived from the auriculo-temporal and the masseteric branches of the mandibular.

The stylo-hyoid and stylo-mandibular ligaments have been previously described.

DISSECTION OF THE UPPER EXTREMITY.

The subject should be placed on its back, and, the thorax being raised by a block placed under the shoulders, the arm is to be extended to a right angle with the trunk and slightly rotated outwards. A narrow board must be placed under the arm to keep it in position, and the hand, with the palm upwards, is to be firmly encircled by bandage to the board.

Surface Marking. — Before commencing the dissection of the arm, the student should carefully examine with the eye and the finger the various inequalities of the surface of the skin, which are caused by, or are landmarks of, important subjacent structures.

Beginning in the middle line, we notice a broad, shallow groove in front of the sternum between the sternal origins of the pectoralis major; about two inches (*5 cm.*) below the upper border of the sternum is a prominent transverse bony ridge (angulus sterni), which corresponds to the junction of the first and second portions of the sternum.

The clavicle may be easily traced, convex as to its sternal half, and concave in its outer half; not placed quite horizontally, but inclined upwards in the present position of the limb, and articulating externally with the prominent acromion process. Extending obliquely downwards and outwards, from the middle of the clavicle, is a groove, marking the separation between the contiguous borders of the deltoid and pectoralis major, and in which may, by deep pressure, be felt the coracoid process. Another groove, passing outwards from the sterno-clavicular joint, indicates the interval between the sternal and clavicular attachments of the pectoralis major. The upper arm below the acromion is rounded, the convexity being caused by the greater and lesser tuberosities of the humerus. In the more common forms of dislocations of the humerus, this roundness is lost, and a depression takes its place. Between the thorax and the arm there is a deep hollow — the axilla — which varies according to the position of the arm to the side. Its front border is formed by the pectoralis major, and its hinder border by the latissimus dorsi; and if the fingers be pushed up into this space, the head of the humerus can easily be felt. The free border of the pectoralis major muscle corresponds with the fifth rib, and below this can be distinguished the lower digitations of the serratus magnus with the external oblique.

Dissection. — The student must now make three incisions through the skin; the first, along the middle of the whole length of the sternum; the second, along the lower border of the clavicle, and down along the front of the upper arm for four inches (*10 cm.*); the third, from the ensiform cartilage, backwards to the posterior border of the axilla.

The skin should now be taken up with the forceps at the upper and inner angle, and when the skin has been so far reflected as to enable the fingers to take it up, lay aside the forceps and use the fingers in their place. The skin should be carefully dissected from the subjacent layer of subcutaneous fascia and fat. In doing so, notice the thin, pale fibres of the broad subcutaneous muscle of the neck—*platysma myoides* (Fig. 14, p. 43).

Beneath this subcutaneous fascia and fat there is a strong deep fascia which closely invests the muscles, and in the axilla it forms a dense fascia which passes from the pectoralis major to the latissimus dorsi.

Cutaneous Nerves. — The numerous nerves which run through the subcutaneous tissue of the skin and mammary gland must be carefully dissected out. They are derived from various sources; some, branches of the superficial cervical plexus, descend over the clavicle; others, branches of the intercostal nerves, come through the intercostal spaces close to the sternum, each with a small artery; a third series, also branches of the intercostal nerves, come out on the side of the chest and run forwards over the outer border of the pectoralis major.

The *supra-clavicular nerves*, which arise from the third and fourth cervical nerves, descend over the clavicle, and are subdivided, according to their direction, into *sternal*, *clavicular*, and *acromial* branches (Fig. 32, p. 80). The *inner* or *sternal* cross the inner end of the clavicle to supply the skin over the upper part of the sternum. The *middle* or *clavicular* pass over the middle of the clavicle and supply the integument over the front of the chest and the mammary gland. The *outer* or *acromial* branches cross over the outer end of the clavicle and distribute their filaments to the skin of the shoulder.

Near the sternum are found the *anterior cutaneous branches* or terminal filaments of the *intercostal nerves*. After piercing the internal intercostal and pectoralis major muscles each nerve sends an inner filament to the skin over the sternum, and an outer larger one, which supplies the skin over the pectoral muscle. Those of the third and fourth intercostal supply also the mammary gland.

Branches of the internal mammary artery, for the supply of the mammary gland, accompany these nerves. During lactation they increase in size, ramifying tortuously over the surface of the gland. They are occasionally as large as the radial at the wrist.

The *lateral cutaneous branches of the intercostal nerves* come out between the digitations of the serratus magnus on the side of the chest, and divide into anterior and posterior branches. The *anterior* branches curve round the free border of the pectoralis major, and then supply the skin over that muscle and the mamma. The *posterior* branches supply the skin of the back of the chest.

Dissection. — Dissect off the superficial fascia and fat with the mammary gland. Thus you will expose the strong *deep*

fascia, which is closely attached to the pectoralis major and deltoid muscles. It is continuous, above, with the fascia of the neck; below, with that of the arm. At the axilla it becomes denser, where it passes from the pectoral to the latissimus dorsi muscles.

Reflect this fascia from the pectoralis major by dissecting parallel with the course of its fibres. The muscle having been fully exposed, observe its shape, the course of its fibres, their origin, and insertion.*

Pectoralis Major. — The pectoralis major is the large triangular muscle in the front of the chest. It *arises* from the anterior surface of the sternal half of the clavicle, from the front of its own half of the sternum, from the cartilages of all the true ribs except the last, and from the aponeurosis of the external oblique muscle of the abdomen. From this extensive origin the fibres converge towards the arm, the upper ones passing downwards and outwards, the middle ones transversely outwards, and the lower fibres upwards and outwards; they terminate in a flat tendon, about two inches in breadth, which is *inserted* into the anterior margin of the bicipital groove of the humerus. The arrangement of its fibres, as well as the structure of its tendon, is peculiar — on vertical cross section is U shape. The lower fibres, which form the boundary of the axilla, are folded beneath the rest, and terminate upon the upper part of the tendon — *i.e.*, nearer to the shoulder-joint; the upper fibres, which arise from the clavicle, and are frequently separated from the main body of the muscle by a slight interval, descend in front of the lower and terminate upon the lower part of the tendon. Consequently the upper and lower fibres of the muscles cross each other previously to their insertion (Fig. 120, p. 316).

The object of this arrangement is to enable all the fibres to act simultaneously when the arm is extended.

The upper part of the tendon sends off a fibrous prolongation, which binds down the long head of the biceps, and is attached to the great tuberosity of the humerus; another tendinous expansion is prolonged backwards to the tendon of the deltoid muscle; and a third passes downwards to be intimately connected with the fascia of the upper arm.

* Sometimes we find a thin little muscle running perpendicularly in front of the inner part of the pectoralis major. This is the *rectus sternalis*, or *sternalis brutorum*. It arises inferiorly by a tendinous expansion from the rectus abdominis, and is connected above to the tendon of the sterno mastoid.

The chief *action* of the pectoralis major is to draw the humerus towards the chest, as in placing the hand on the opposite shoulder, or in pulling an object towards the body. When the arm is raised and made the fixed point the muscle assists in raising the trunk, as in climbing. Thus, too, on emergency, it can act as an auxiliary muscle of inspiration.

Between the pectoralis major and the deltoid, the great muscle covering the shoulder, is an interval varying in extent in different subjects, but always more marked towards the clavicle. It contains a small artery — the *thoracica humeraria* — and the *cephalic vein*, which ascends on the outer side of the arm and empties itself into the axillary. This interval is the proper place to feel for the coracoid process. In doubtful injuries about the shoulder this point of bone is a good landmark in helping the surgeon to arrive at a correct diagnosis.

The pectoralis major is supplied with *nerves* by the external anterior thoracic and some filaments from the internal anterior thoracic branches of the brachial plexus; with blood, by the long and short thoracic branches of the axillary artery.

Dissection. Anatomy of the Infra-clavicular Region. — Reflect the clavicular part of the pectoralis major by detaching it from the clavicle, and turn it downwards; in doing so, notice a small nerve, the external anterior thoracic, which enters the under surface of this part of the muscle. Beneath the portion thus reflected, part of the pectoralis minor will be exposed. In this triangle — bounded, above, by the clavicle; below, by the upper border of the sternal origin of the pectoralis major; and, on the outer side, by the deltoid — is an important space in which the relative position of the following objects must be carefully examined: —

Costo-coracoid Membrane. — *a.* A strong ligamentous expansion, called the *costo-coracoid membrane* or *clavi-pectoral fascia,* extends from the cartilage of the first rib to the coracoid process. Between these points it is attached to the clavicle, and forms a complete investment for the subclavius muscle.* Its lower crescent-shaped edge arches over, and protects the axillary vessels and nerves; from this edge is prolonged downwards a funnel-shaped fascia, which covers the axillary vessels,

* This fascia extends to the cephalad or superior border of the pectoralis minor muscle; the fascia then divides into three layers, the ventral or anterior two surrounding the muscle, and finally being lost in the axillary fascia; the dorsal or posterior layer being lost on the vessels. — A. H.

forming the anterior portion of their sheath, the posterior being formed by a prolongation of the deep cervical fascia. The front portion of this sheath is perforated by the cephalic vein, the thoracica acromialis artery and vein, the anterior thoracic nerves, and the superior thoracic artery. This fascia must be removed.

b. The subclavius muscle enclosed in its fibrous sheath.

c. The axillary vein, artery, and brachial plexus of nerves.

d. Two arteries, the superior or short thoracic and the thoracica acromialis.

e. The termination of the cephalic vein in the axillary.

f. Two nerves, the external and internal anterior thoracic, which descend from the brachial plexus below the clavicle, and cross in front of the axillary vessels to supply the pectoral muscles.

Subclavius. — This muscle lies between the clavicle and the first rib. It *arises* from the first rib by a short round tendon at the junction of the bone and cartilage in front of the costo-clavicular ligament, and is *inserted* into the groove on the under surface of the clavicle as far outwards as the coraco-clavicular ligament. Its *nerve* comes from the fifth and sixth cervical nerves. Its *action* is to depress the clavicle, and prevent its too great elevation (Fig. 120, p. 316).

Relative Position of the Axillary Vessels and Nerves. — In the infra-clavicular space before us are the great vessels and nerves of the axilla in the first part of their course. They lie at a great depth from the surface. They are surrounded by a sheath of fascia, which descends with them beneath the clavicle. Their relations with regard to each other are as follows: The axillary vein lies in front of the artery, and rather to its thoracic side. The brachial plexus of nerves is situated above the artery, and on a posterior plane. The plexus consists of two, or sometimes three, large cords, which result from the union of the anterior branches of the four lower cervical, and the first thoracic nerves. The course and relations of the axillary artery will be examined subsequently.

Superior Thoracic and Acromio-Thoracic Arteries. — These are two branches which arise from the axillary artery in the first part of its course, above the pectoralis minor. The *superior thoracic* frequently arises in common with the acromio-thoracic, and passing along the upper border of the pectoralis minor, descends between this muscle and the pectoralis major,

supplying both, and anastomosing with the intercostal and internal mammary arteries. The *thoracica acromialis* is given off just above the pectoralis minor, and shortly divides into three sets of branches: viz., two or three small *thoracic branches* to the serratus magnus and pectoral muscles; the *thoracica humeraria*, which descends with the cephalic vein, in the interval between the pectoralis major and deltoid, and ramifies in both; and lastly, the *acromial branch*, which passes over the coracoid process to the under surface of the deltoid, which it supplies, and communicates with the posterior circumflex, a branch of the axillary, and the supra-scapular, a branch of the subclavian. A constant though small branch, the *clavicular*, runs along the anterior aspect of the subclavius. All these arteries are accompanied by veins, which most frequently empty themselves into the cephalic, but occasionally into the axillary vein.

Cephalic Vein. — The cephalic vein is one of the principal cutaneous veins of the arm. Commencing on the back of the thumb and forefinger, it runs up the radial side of the forearm, in front of the elbow-joint; thence ascending along the outer edge of the biceps, it runs up the interval between the pectoralis major and deltoid, pierces the costo-coracoid membrane, crosses over the axillary artery, and finally empties itself into the axillary vein.*

Anterior Thoracic Nerves. — These nerves come from the brachial plexus below the clavicle to supply the pectoral muscles. There are generally two — an external and an internal — one for each pectoral muscle. The *external*, the more superficial, arises from the outer cord of the brachial plexus, passes over the axillary artery and vein, pierces the costo-coracoid membrane, and supplies the pectoralis major on its under aspect: it communicates with the next nerve by a filament which forms a loop on the inner side of the artery; the *internal*, and smaller branch, comes from the internal cord, and descends between the axillary artery and vein (occasionally through the vein) to supply the pectoralis minor on its under surface, some of its filaments passing through this muscle to the pectoralis major.

Difficulty of Tying the First Part of the Axillary Artery. — From this view of the relations of the axillary artery in

* The cephalic vein, in some cases, runs over the clavicle to join the external jugular; or there may be a communication (termed jugulo-cephalic) between these veins.

the first part of its course, some idea may be formed of the difficulty of passing a ligature round it in this situation. In addition to its great depth from the surface, varieties sometimes occur in the position of the nerves and veins, which render the operation still more embarrassing. For instance, the anterior thoracic nerves may be more numerous than usual, and form by their mutual communication a plexus around the artery. A large nerve is often seen crossing obliquely over the artery, immediately below the clavicle, to form one of the roots of the median nerve. The cephalic vein may ascend higher than usual, and open into the subclavian; and as it receives large veins corresponding to the thoracic axis, a concourse of veins would be met with in front of the artery. Again, it is by no means uncommon to find a deep-seated vein, the supra-scapular, crossing over the artery to join the axillary vein.

DISSECTION OF THE AXILLA.

Sebaceous Glands. — On the under surface of the skin of the axilla, near the roots of the hairs, are numerous sebaceous glands. They are of a reddish-brown color, and rather larger than a pin's head.

Axillary Fascia. — This dense fascia, which lies immediately beneath the skin of the axilla, is a continuation of the general fascial investment of the muscles. It closes in and forms the floor of the cavity of the axilla. Externally, it is strengthened by fibres from the tendons of the pectoralis major and latissimus dorsi, and is continuous with the fascia of the arm; internally, it is prolonged on the side of the chest, over the serratus magnus muscle; in front and behind, it divides, so as to enclose between its layers the muscles which form the boundaries of the axilla. Thus the anterior layer encloses the two pectoral muscles, and is connected with the coracoid process, the costo-coracoid ligament, and the clavicle; the posterior layer encloses the latissimus dorsi, and passes backwards to the spine.

A subcutaneous artery, sometimes of considerable size, is often found in the substance of the axillary fascia. It generally arises from the brachial, or from the lower part of the axillary artery, and runs across the floor of the axilla towards the lower edge of the pectoralis major. It is not a named branch,

but should be remembered, as it would occasion much hemorrhage if wounded in opening an abscess.

Dissection and Contents of the Axilla.—Reflect the axillary fascia, to display the boundaries and the contents of the axilla. The dissection of this space is difficult, and must be done cautiously. Bear in mind that the trunk blood-vessels and nerves run through the *upper* and *outer* part of the axilla; that the long thoracic artery runs along the *anterior* border, and the subscapular artery along the *posterior*. Commence dissecting, therefore, in the middle; break down with the handle of the scalpel the loose connective tissue, fat, and lymphatic glands, which occupy the cavity. You will soon discover some cutaneous nerves coming out between the ribs, and then crossing the axillary space. These nerves are the *posterior lateral cutaneous branches of the intercostal nerves;* they perforate the intercostal spaces between the digitations of the serratus magnus, midway between the sternum and the spine, and divide into anterior and posterior branches. The *anterior* turn over the pectoralis major, to supply the skin on the front of the chest and the mammary gland. The *posterior* pass backwards over the latissimus dorsi, and are distributed to the skin covering this muscle and the scapula.

Intercosto-humeral Nerves.—The posterior lateral branch of the second intercostal nerve requires a special description. It is larger than the others, and is called the *intercosto-humeral,* because it supplies the integuments of the arm. It comes through the second intercostal space, traverses the upper part of the axilla, where it receives a branch of the lesser internal cutaneous nerve (nerve of Wrisberg), and, piercing the fascia, terminates in filaments, which are distributed to the skin on the inner side and back of the arm, as low as the internal condyle. The corresponding branch of the third intercostal is also an *intercosto-humeral* nerve. It receives a branch from the second, and runs a similar course. The distribution of these nerves* accounts for the pain down the arm which is sometimes experienced in pleurisy.

Boundaries of the Axilla.—The axilla is a conical space, of which the *apex* is beneath the clavicle, and the *base* between the pectoralis major and the latissimus dorsi. Obviously it varies in capacity according to the position of the arm to the

* In carcinoma of the breast, pain is transmitted to the elbow when the deep lymphatics and the muscles are invaded.

side. On the *inner* side, it is bounded by the four upper ribs, with their corresponding intercostal muscles and the serratus magnus; on the *outer*, by the humerus, covered by the coraco-brachialis and biceps; in *front*, by the pectoralis major and minor; *behind*, by the latissimus dorsi, teres major, and sub-scapularis. Its anterior and posterior boundaries converge from the chest, so that the axilla becomes narrower towards the arm. With a full view of the axilla before you, bear in mind that pus

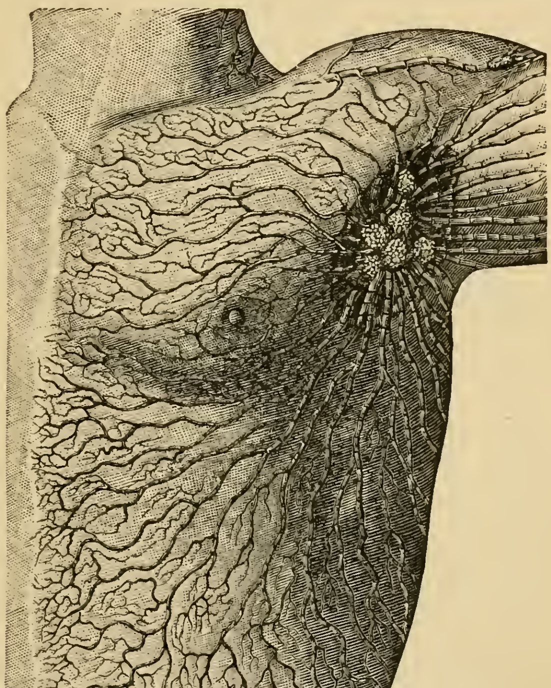


FIG. 119.—THORACIC AND BRACHIAL LYMPHATIC VESSELS EMPTYING INTO THE AXILLARY LYMPHATIC GLANDS.

may burrow under the pectoral muscles, or under the scapula, or that it may run up beneath the clavicle and point in the neck, if the abscess be allowed to remain unopened (Fig. 120).

Axillary Lymphatic Glands. — The axillary glands form a continuous chain, beneath the clavicle, with the cervical glands. They are from ten to twelve in number, of a reddish-brown color, and variable size. Most of them lie near the axillary

vessels; others are embedded in the loose tissue of the axilla; sometimes one or two small ones are observed along the lower border of the pectoralis major. They are supplied with blood by a branch — *thoracica alaris* — of the axillary artery, and by branches from the thoracic and subscapular arteries (Fig. 119).

These glands receive the lymphatics from the arm, from the front and side of the chest, and from the outer half of the mammary gland. It is these glands which become enlarged in cancer of the mammary gland. From these glands the efferent

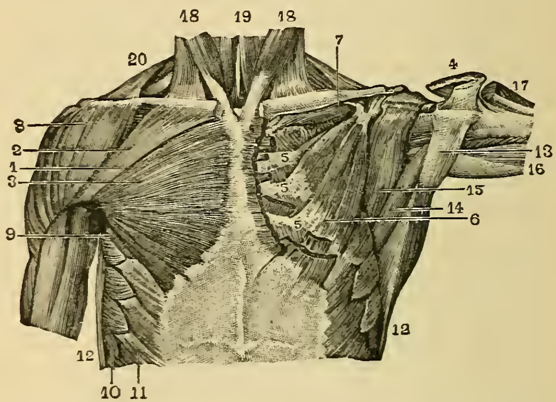


FIG. 120. — MUSCLES OF THE ANTERIOR PART OF THE THORAX.

1. Pectoralis major. 2. Its clavicular portion. 3. Its sternal portion. 4. Cut portion of the whole muscle deflected to show the long head of the biceps, showing also the turning of the fibres of the muscle before their insertion. 5. Muscular fasciculi by which the pectoralis major arises from the costal cartilages. 6. Pectoralis minor m. 7. Subclavius m. 8. Deltoid m., separated from the superior border of the pectoralis major by a wedge-shaped cellular interspace, the base being above. 9. Inferior border of the pectoralis minor. 10. Digitations of the serratus magnus m. 11. Digitations of the external oblique m. 12. Border of the latissimus dorsi m. 13. Tendon of this muscle passing around the teres major m. to be attached to the inner lip of the bicipital groove of the humerus. 14. Teres major m. 15. Subscapularis m. 16. Long head of the triceps m. 17. Margin of deltoid m. 18. Sterno-cleido-mastoid m. 19. Origin of sterno-hyoideus m. 20. Trapezius m.

lymphatics pass along with the subclavian artery and terminate, on the right side, in the right lymphatic duct; and, on the left side, in the thoracic duct.

Dissection. — Now cut through the pectoralis major, about the middle, and turn the inner part of the muscle towards the sternum, and the outer part towards the arm. The pectoralis minor is thus exposed, together with the ramifications of the short and long thoracic arteries. Preserve the arteries, as far as possible, in connection with the main trunks.

Pectoralis Minor. — This triangular muscle *arises* from the third, fourth, and fifth ribs, near the costal cartilages, and from

the thick fascia over the intercostal spaces. The fibres run obliquely upwards and outwards, and converge to a strong tendon, which is *inserted* into the anterior surface of the coracoid process. The tendon is connected to that of the coraco-brachialis and biceps by a strong fascia, which forms a protection for the subjacent axillary vessels and nerves. The *action* of this muscle is to draw the scapula downwards and forwards. Its *nerve* is derived from the internal anterior thoracic.

Dissection. — Having examined the muscles which form the anterior boundary of the axilla, we pass now to the course and relations of the axillary artery and its branches. To have a clear view, reflect the subclavius from its insertion, and cut the pectoralis minor through its middle.

Axillary Artery, its Course and Relations. — This artery, the continuation of the subclavian, takes the name of *axillary* at the outer border of the first rib. It then passes downwards and outwards, through the upper part of the axilla, beneath the two pectoral muscles, and along the inner border of the coraco-brachialis as far as the lower border of the tendon of the teres major, beyond which it is continued under the name of the brachial. Its course is divided for convenience of description into three parts: the first lies above the pectoralis minor; the second behind that muscle; and the third below it.

In the *first part* of its course the artery is *covered* by the pectoralis major and the costo-coracoid membrane, the subclavius, and is crossed by the cephalic and acromio-thoracic veins. On its *inner side*, and slightly in front, is the axillary vein; on its *outer side* is the brachial plexus of nerves; *behind* it are the first intercostal space, the second digitation of the serratus magnus, and the posterior thoracic nerve (external respiratory of Bell).

In the *second part* of its course it lies *behind* the pectoralis major and minor; on its *inner side* is the axillary vein, still slightly anterior, but separated from the artery by the inner cord of the brachial plexus; on its *outer side* is the outer cord of the brachial plexus; and *behind* it is the posterior cord of the plexus, and also a quantity of loose connective tissue which separates it from the subscapularis muscle. The inner head of the median nerve is often in front of the artery in this part of its course.

In the *third part*, in *front* of the artery, are the pectoralis major, the two roots of the median nerve, converging like the

letter V, and lower down is the skin and the fascia of the arm; on the *outer side* are the coraco-brachialis, the musculo-cutaneous, and median nerves; on the *inner side* are the axillary vein, the ulnar, and the two internal cutaneous nerves; *behind* it are, in succession, the subscapularis, the latissimus dorsi, the teres major, and the musculo-spiral and circumflex nerves.

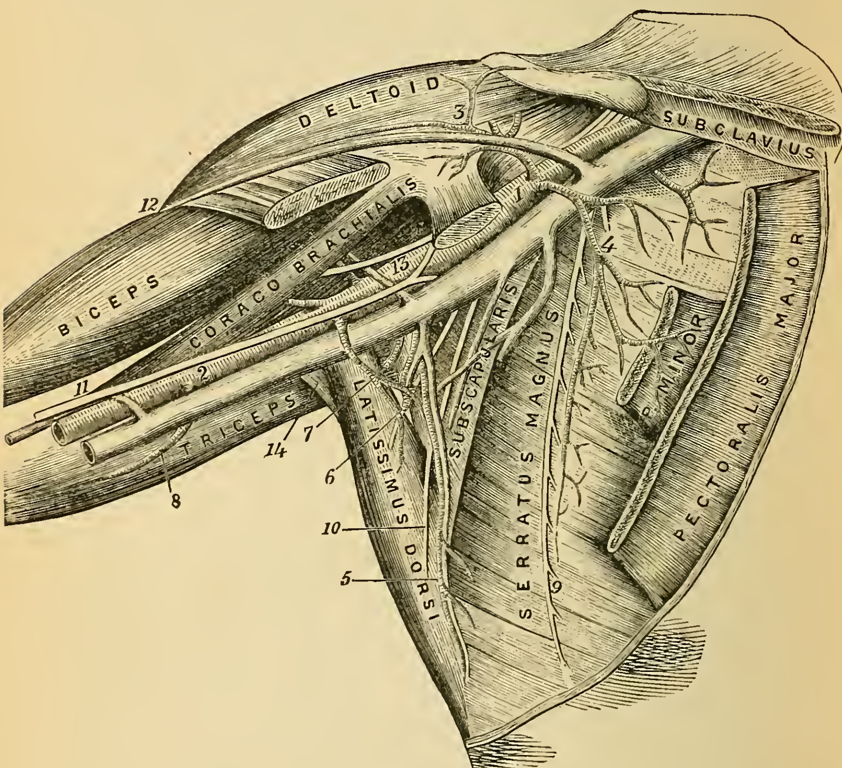


FIG. 121.—DIAGRAM OF AXILLA.

1. Axillary artery. 2. Brachial artery. 3. Thoracica humeraria artery. 4. Superior thoracic artery. 5. Subscapular artery. 6. Dorsalis scapulæ artery. 7. Posterior circumflex artery. 8. Superior profunda artery. 9. Posterior thoracic nerve. 10. Long subscapular nerve. 11. Median nerve. 12. Cephalic vein. 13. Musculo-cutaneous nerve. 14. Teres major.

Branches of the Axillary Artery.—The number and origin of these branches often vary, but their general course is in most cases similar, and they usually arise in the following order:—

a. The *superior* or *short thoracic* arises above the pectoralis minor, and divides into branches, which have been already described (p. 311).

b. The *acromial thoracic* also rises above the pectoralis minor, and gives off numerous branches already described (p. 311).

c. The *alar thoracic*, variable in its origin, supplies the lymphatic glands and the connective tissue of the axilla.

d. The *inferior* or *long thoracic artery* (external mammary) runs along the lower border of the pectoralis minor to the side of the chest. It supplies the mammary gland, the serratus magnus and pectoral muscles, and maintains a free anastomosis with the short thoracic, internal mammary, and intercostal arteries.

e. The *subscapular* is the largest branch of the axillary; it arises opposite the lower border of the subscapularis, and, after running a short course of about an inch and a half (*3.8 cm.*), divides into an anterior and posterior branch.

The *anterior branch* runs along the anterior edge of the subscapularis towards the lower angle of the scapula. Its numerous branches supply the subscapularis, latissimus dorsi, serratus magnus, and teres major, and anastomose with the intercostal and thoracic arteries, and with the posterior scapular (a branch of the subclavian).

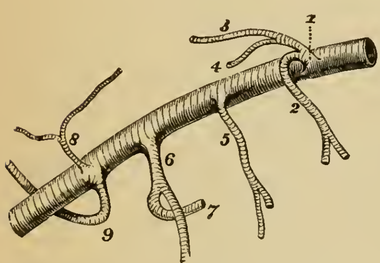


FIG. 122. — PLAN OF THE BRANCHES OF THE AXILLARY ARTERY.

1. Thoracic axis, giving off. 2. Short thoracic. 3. Thoracica acromialis. 4. Thoracica humeraria. 5. Long thoracic. 6. Subscapular. 7. Dorsalis scapulæ. 8. Anterior circumflex. 9. Posterior circumflex.

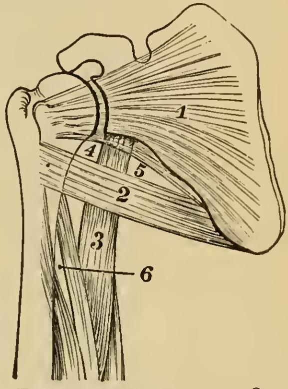


FIG. 123. — DIAGRAM OF THE ORIGINS OF THE TRICEPS.

1. Subscapularis. 2. Teres major. 3. Long head of triceps. 4. Square space for post. circumflex a. and n. 5. Triangular space for dorsalis scapulæ n. 6. Space for musculospiral n., and superior profunda a.

The *posterior branch* (dorsalis scapulæ) runs to the back of the scapula, through a triangular space, bounded in front by the long head of the triceps; below, by the teres major; and, above, by the subscapularis and teres minor (Fig. 123). It gives off a small branch which enters the subscapular fossa beneath the subscapularis, supplying it, and anastomosing with the suprascapular and posterior scapular arteries. On the back of the scapula it divides into two branches: one runs in the groove on the axillary border of the scapula, lying beneath the teres minor, and ramifies in the infraspinous fossa between the bone and the infraspinatus; the other runs down between the teres minor and major on their dorsal aspects, and passes to the inferior angle of the scapula, anastomosing with the posterior and suprascapular arteries. The subscapular vein empties itself into the axillary vein.

f. The *posterior circumflex artery* arises from the back of the axillary artery, and is as large as the subscapular, close to which it is given off; or both may

arise by a common trunk from the axillary. It passes backwards, with its corresponding veins and nerve, through a quadrilateral space, bounded above by the subscapularis and teres minor, below by the teres major, externally by the neck of the humerus, and internally by the long head of the triceps (Fig. 123). It then winds round the back of the neck of the humerus, and is chiefly distributed to the under surface of the deltoid.

Besides the deltoid, the posterior circumflex artery supplies the long head of the triceps, the head of the humerus, and the shoulder-joint. It inosculates above with the acromio-thoracic and suprascapular arteries, below with the ascending branch of the superior profunda (a branch of the brachial), and in front with the anterior circumflex artery. Should you not find the posterior superior circumflex artery in its normal position, look for it (as a branch of the brachial) below the tendon of the teres major.

g. The *anterior circumflex artery*, much smaller than the posterior, runs in front of the neck of the humerus, above the tendon of the latissimus dorsi. It passes directly outwards beneath the coraco-brachialis and short head of the biceps, close to the bone, and terminates in the under surface of the deltoid, where it inosculates with the posterior circumflex.

The anterior circumflex artery sends a small branch which runs with the long tendon of the biceps up the groove of the humerus, and is called, on that account, the *bicipital* artery. It supplies the shoulder-joint and the neck of the humerus.

If the axillary were tied below the pectoralis minor the collateral circulation would be established by the suprascapular and its branches anastomosing with the subscapular, the dorsalis scapulæ, and the posterior circumflex; the posterior scapular with the dorsalis scapulæ and subscapular arteries.*

Axillary Vein. — The *axillary vein* is formed by the continuation upwards of the basilic vein, and extends from the lower border of the teres major to the outer border of the first rib. It receives the venæ comites of the brachial artery near the lower border of the subscapularis. It receives the subscapular and the other veins corresponding to the branches of the axillary artery, with the exception of the circumflex, which usually join either the subscapular or one of the venæ comites. The axillary near its termination also receives the cephalic vein.

The axillary vein in the upper part of its course lies in front of the artery, and close to its sternal side; in the lower two-thirds of its course the vein lies still to the sternal side of the artery, but is separated from it by some of the nerves of the brachial plexus.†

* The axillary artery varies much as to the branches it gives off; occasionally (1 in 33) it gives off the radial artery; more rarely (1 in 72) it gives off the ulnar; and more rarely still (1 in 506) it gives off the interosseous artery.

† It must be remembered that the size of the axillary vein compared with the brachial is very much larger, consequently the greater danger in mistaking it for the axillary artery and from puncture when the axilla has to be opened. — A. H.

Axillary or Brachial Plexus of Nerves. — This plexus is formed by the anterior trunks of the four lower cervical and first thoracic nerves, and receives also a small communicating branch from the fourth cervical nervē. The plexus is broad at the lower part of the neck, where it emerges between the anterior and middle scalene muscles; but it gradually contracts as it descends beneath the clavicle into the axilla, and on a level with the coracoid process distributes its large branches to the upper limb.

The arrangement of the cervical nerves in the formation of

FIG. 124. — THE BRACHIAL PLEXUS OF NERVES.

C 4–8. The five lower cervical nerves. D 1. The first thoracic nerve. 9. The rhomboid nerve — to rhomboidei major and minor. 10. The supra-scapular nerve — to supra and infra spinati. 11. The nerve to the subclavius. 12. External anterior thoracic nerve — to pectoralis major. 13. Internal anterior thoracic nerve — to pectoralis minor. 14, 15, 16. The subscapular nerves — to subscapularis, latissimus dorsi, and teres major. 17. Lesser internal cutaneous nerve. 18. Musculo-cutaneous nerve. 19. Musculo-spiral nerve. 20. Median nerve. 21. Circumflex nerve — to deltoid and teres minor. 22. Ulnar nerve. 23. Internal cutaneous nerve. 24. External respiratory nerve of Bell, or posterior thoracic nerve.

the plexus is variable, often not alike on both sides.* The most frequent disposition is this — the fifth and sixth cervical unite at the outer border of the scalenus medius to form an upper cord; the eighth and the first thoracic form between the scaleni muscles a lower cord; the seventh cervical runs alone,

* Frequently the second thoracic nerve sends upwards a communicating filament to the first thoracic nerve. — (*Journal of Anatomy*, vol. xi. p. 539.)

as a middle cord, for a short distance. Each of these nerves divides, just external to the outer border of the scalenus medius, into an anterior and a posterior branch; the anterior branches given off from the fifth, sixth, and seventh cervical form the *outer cord* of the plexus; the anterior branches given off from the eighth cervical and the first thoracic form the *inner cord;* while the posterior branches of all the nerves — viz., the fifth, sixth, seventh, eighth cervical, and the first thoracic — unite to form the *posterior cord.*

At first these cords are placed on the outer side of the axillary artery, but behind the pectoralis minor they are situated one on the outer side of, one on the inner side of, and one behind, the axillary artery.

The brachial plexus gives off some branches above the clavicle, which were dissected with the neck (p. 137). Below the clavicle, it gives off the following:—

From the *outer* cord proceed an anterior thoracic branch, the musculo-cutaneous, and the outer head of the median; from the *inner* cord proceed the internal anterior thoracic nerve, the inner head of the median, the ulnar, the internal cutaneous, and the lesser internal cutaneous; from the *posterior* cord proceed the three subscapular nerves, the circumflex, and the musculo-spiral.

The *anterior thoracic* nerves have been described (p. 312).

Subscapular Nerves. — The *three subscapular* nerves are found on the surface of the subscapularis. They come from the posterior cord of the brachial plexus, and supply, respectively, the latissimus dorsi, teres major, and subscapularis. The nerve to the latissimus dorsi (*long subscapular nerve*) runs with the anterior branch of the subscapular artery to the lower border and inner surface of the muscle.

The *nerve to the teres major* is either a branch of the preceding, or comes separately from the posterior cord. It lies nearer to the humerus than the long subscapular. It gives off also a small branch to the anterior border of the subscapularis.

The *nerve to the subscapularis* arises from the posterior cord, higher than the others, and enters the muscle not far from its upper border in company with a small artery.

Circumflex Nerve. — The circumflex nerve accompanies the *posterior circumflex artery.* This large nerve comes from the posterior cord, and, after giving a small filament to the shoulder-joint, passes, with its companion artery, through the quadrilate-

ral space (Fig. 123 p. 319) to the under surface of the deltoid. Here the nerve divides into an upper and a lower branch. The *upper* supplies the anterior part of the deltoid and the skin over it; the *lower* supplies the back part of the deltoid, and gives the nerve to the teres minor,* upon which nerve sometimes a little gangliform swelling can be seen: it enters the under aspect of the middle of this muscle. After furnishing these muscular branches, the nerve turns round the posterior border of the deltoid, and diverges in filaments which supply the skin over the back of this muscle and over the long head of the triceps.

Latissimus Dorsi. — This broad, flat muscle forms the posterior margin of the axilla. It *arises* from the external lip of the crest of the ilium, from an aponeurosis attached to the spinous processes of the six lower thoracic, of all the lumbar, and of the sacral vertebræ and their supraspinous ligament, and by fleshy digitations from the three or four lower ribs, interdigitating with those of the external oblique; in some cases, as it passes over the inferior angle of the scapula, it has an additional origin from the angle. Its fibres converge from this large origin, and the muscle is *inserted* into the bottom of the bicipital groove of the humerus — as high up as the lesser tuberosity — by a broad flat tendon, which curves round the lower border of the teres major. The axillary vessels and nerves lie upon the tendon close to its insertion. Its *nerve* is the long subscapular branch from the posterior cord of the brachial plexus, and it enters the muscle close to its anterior border, in company with a large branch of the subscapular artery (Fig. 125).

Teres Major. — This muscle lies behind, and to the inner side of the latissimus dorsi, is closely connected with it, and assists in forming the posterior boundary of the axilla. It *arises* from the oval surface of the dorsal aspect of the lower angle of the scapula, and from the fibrous septa between it and the teres minor and infraspinatus, and is *inserted* by a broad flat tendon, about two inches (*5 cm.*) in length, behind the latissimus dorsi, into the posterior margin of the bicipital groove of the humerus. The tendon extends below that of the latissimus dorsi, and a bursa or sac, lubricated with serum, intervenes between the two tendons. The *action* of this and the preceding muscle is to draw the humerus inwards and backwards. The latissimus dorsi when

* This branch to the teres minor is said to be constant in all mammalia that have been examined in reference to this point.

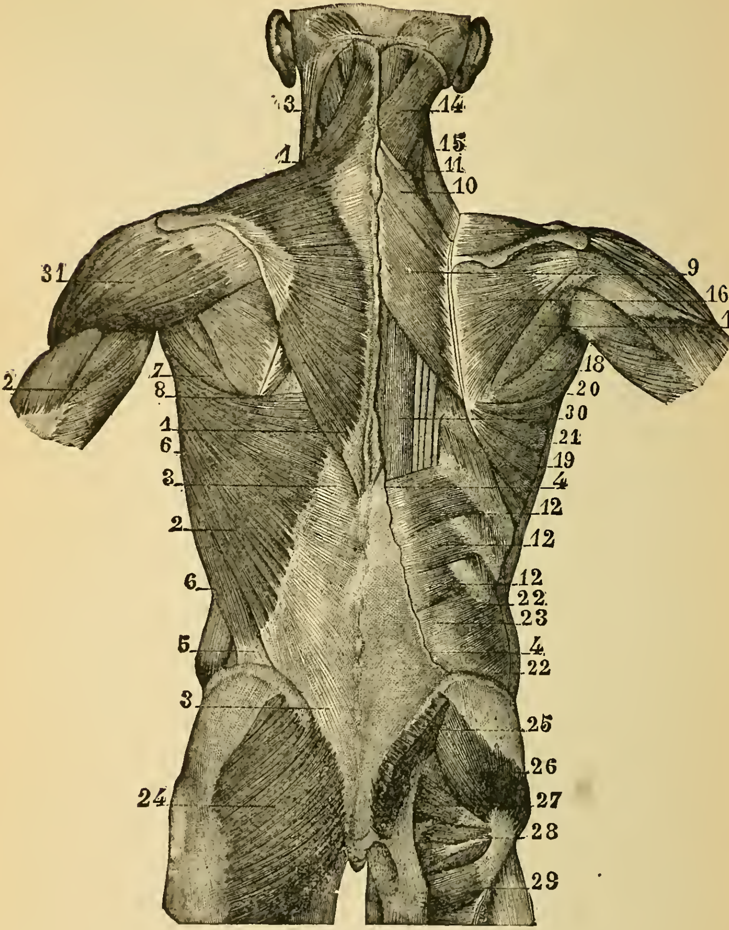


FIG. 125.— MUSCLES OF THE BACK (SUPERFICIAL).

1. Trapezius. 2. Latissimus dorsi. 3, 3. Sacro-lumbar aponeurosis. 4. Portion of the fascia anterior to the latissimus dorsi. 5. Fasciculus by which this muscle is attached to the crest of the ilium. 6. External border of the same. 7. Teres major. 8. Superior border of the latissimus dorsi passing over the teres major. 9. Rhomboid major. 10. Rhomboid minor. 11. Superior border of the serratus post. superior. 12, 12, 12. The three fasciculi of the serratus post. inferior. 13. Sterno-cleido-mastoid. 14. Splenius. 15. Levator anguli scapulæ. 16. Infra-spinatus. 17. Teres minor. 18. Teres major. 19. Cut latissimus dorsi. 20. Scapular attachment of the latissimus dorsi. 21. Inferior portion of the serratus magnus. 22, 22. Posterior part of the internal oblique. 23. Posterior aponeurosis of this muscle uniting with that of the serratus posticus inferior and the latissimus dorsi, forming the sacro-lumbar aponeurosis. 24. Gluteus maximus. 25. Cut origin of this muscle. 26. Gluteus medius. 27. Pyramidalis. 28. The tendon of the obturator internus and the superior and inferior gemelli. 29. Quadratus femoris. 30. Sacro-lumbalis and longissimus dorsi. 31. Deltoid. 32. Triceps.

the humerus is fixed will raise the trunk, is used in turning a back summersault, and by its costal attachments will assist in forced inspiration. Its *nerve* is the middle subscapular, and lies along the dorsalis scapulæ artery (Figs. 121, 125).

Subscapularis. — This muscle *arises* from the posterior two-thirds of the subscapular fossa of the scapula, with the exception of the angles, neck, and the posterior border, and from the intermuscular septa attached to the bony ridges. Its fibres converge to a strong tendon, which passes under the axillary vessels and nerves, over the inner side of the shoulder-joint, and is *inserted* into the lesser tuberosity of the humerus, and into the neck of the humerus for an inch (*2.5 cm.*) below it. The tendon of the muscle is intimately connected with the capsular ligament of the shoulder-joint, and between the base of the coracoid process and the tendon is a bursa, which communicates with the joint. Its *action* is to rotate the humerus inwards, and when the arm is raised to draw it to the side. Its *nerves* come from the upper and middle subscapular nerves.

Serratus Magnus. This muscle covers the side of the chest like a girth. It *arises* from the front of the outer surfaces of the eight upper ribs by nine slips or digitations, the second rib having two. Its fibres converge, and are *inserted* into the posterior border of the scapula in the following manner: the first two digitations are attached into the upper angle of the scapula; the third and fourth digitations along nearly the whole length of the posterior border; the remainder are inserted into the inferior angle. Its *action* is to draw the scapula forwards, *i.e.*, rotates the scapula on the acromial end of the clavicle. In paralysis of the deltoid this rotation is very marked by fixing the scapula on the clavicle. When the scapula is fixed the muscle will elevate the ribs, and hence is an accessory inspiratory muscle, as can be seen in the asthmatic. After the deltoid has raised the arm to a right angle with the trunk this muscle with trapezius will elevate the arm above the head. (A. H.) It is supplied by the following *nerve*, which is seen on its outer surface.

Posterior Thoracic or External Respiratory Nerve of Bell. — This nerve supplies the serratus magnus only. It comes from the fifth and sixth cervical nerves; and, after passing through the scalenus medius, runs behind the axillary vessels, along the outer surface of the serratus magnus, each digitation receiving a separate filament.

DISSECTION OF THE UPPER ARM.

Surface Marking. — In front of the upper arm may be distinguished the long prominence of the biceps muscle, and lower down at the bend of the elbow its tendon may be easily felt. The bend of the elbow, in muscular subjects, presents a triangular depression, with its boundaries formed on the inner side by the pronator teres, and on the outer side by the brachio-radialis (*supinator longus*). Superficially in this space the subcutaneous veins can be recognized, of which a fuller description will be entered into later on. On the inner side of the elbow, the internal condyle of the humerus is very prominent, and behind this is the olecranon; between these is a hollow in which may be felt the ulnar nerve. The olecranon is situated nearer the internal than the external condyle, which is visible on the outer side; below this, is a dimple which corresponds with the head of the radius.

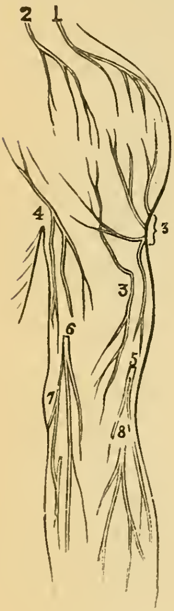


Fig. 126. — Distribution of Cutaneous Nerves to the Front of the Shoulder and Arm.

1. Acromial branches of the superficial cervical plexus. 2. Clavicular branches of the superficial cervical plexus. 3. Cutaneous branches of the circumflex nerve. 4. Branches of the internal cutaneous nerve. 5. External cutaneous branch of the musculo-spiral nerve. 6. Internal cutaneous nerve. 7. Its posterior cutaneous branch. 8. The cutaneous branch of the musculo-cutaneous nerve.

Dissection. — Continue the incision down the inner side of the arm as far as two inches (*5 cm.*) below the elbow, and then make a transverse incision from the inner to the outer side of the forearm. Reflect the skin, and trace out the cutaneous nerves and the numerous veins in front of the elbow.

Cutaneous Nerves. — On the inner side of the arm are the intercosto-humeral, the internal cutaneous branch of the musculo-spiral, the internal cutaneous, and the lesser internal cutaneous (nerve of Wrisberg) nerves; on the outer side are the cutaneous branches of the circumflex, the external cutaneous branches of the musculo-spiral, and lower down is the musculo-cutaneous nerve.

The filaments of the *intercosto-humeral nerves* (p. 314) descend along the inner and posterior part of the arm as far as the olecranon, and communicate with the internal cutaneous branch of the musculo spiral nerve.

The *internal cutaneous nerve* perforates the fascia, with the basilic vein, about the middle of the arm, and divides into an anterior and a posterior branch; the *anterior* passes down in front of the arm (as a rule, beneath the median basilic vein), and supplies the skin as far as the wrist, communicating with a cutaneous branch of the ulnar nerve; the *posterior* winds round to the back of the forearm behind the internal condyle as far as the wrist, and communicates above the elbow with the nerve of Wrisberg, and above the wrist with the dorsal branch of the ulnar nerve.

The *lesser internal cutaneous* (*nerve of Wrisberg*) perforates the fascia about the lower third of the arm, and supplies the skin over the internal condyle and the olecranon. This nerve, as it lies close to the axillary vein, communicates with the first or second intercosto-humeral nerve.

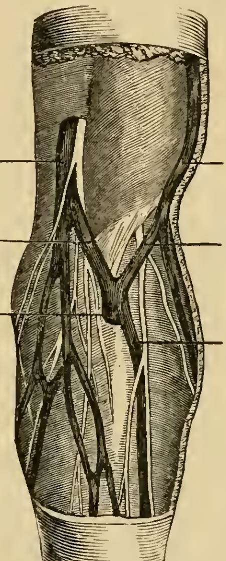


FIG. 127.—SUPERFICIAL VEINS AND NERVES AT THE BEND OF THE LEFT ELBOW.

The *internal cutaneous branch of the musculo-spiral nerve* pierces the fascia and supplies the skin of the inner and posterior aspect of the middle of the arm as far as the olecranon.

The *cutaneous branches of the circumflex nerve* pierce the fascia over the insertion of the deltoid, and supply the skin of the upper half of the arm on its outer side.

The *external cutaneous branches of the musculo-spiral nerve* are two in number: the *upper* and smaller accompanies the cephalic vein in the lower half of the arm; the *lower* may be traced down the outer and back part of the forearm nearly as far as the wrist, where it joins the posterior branch of the musculo-cutaneous nerve.

On the outer side of the tendon of the biceps the *cutaneous branch of the musculo-cutaneous nerve* perforates the fascia, and divides into many filaments, which supply the skin of the outer part of the forearm.

Disposition of Veins in Front of the Elbow. — Attention should now be directed to the disposition of the veins in front of the elbow. In cleaning these veins, take care not to divide the branches of the internal and external cutaneous nerves which pass over and under them.

The following is the ordinary arrangement of the superficial veins at the bend of the elbow (Fig. 127). On the outer side is the *radial;* on the inner side is the *ulnar vein,* formed by the junction of the anterior and posterior ulnar cutaneous veins; in the centre is the median, which divides into two branches, the external of which, uniting with the radial to form the cephalic vein, is called the *median cephalic;* the internal, uniting with the ulnar to form the basilic, is named the *median basilic.* Near its bifurcation, the median vein communicates by a branch (mediana profunda) with the deep veins which accompany the arteries of the forearm.

Trace the *cephalic vein* up the arm. It runs along the outer border of the biceps to the groove between the pectoralis major and the deltoid, and dipping down between these two muscles, terminates in the axillary vein immediately above the pectoralis minor.

The *basilic vein,* the largest of the veins of the upper arm, ascends along the inner side of the arm with the internal cutaneous nerve. Near the middle of the arm, it perforates the fascia, and empties itself either into the internal vena comes of the brachial artery or into the axillary vein.

Relation of the Cutaneous Nerves and Veins at the Elbow. — The principal branches of the cutaneous nerves pass beneath the veins; that is to say, as a rule, the internal cutaneous passes behind the median basilic vein, and the external cutaneous behind the median cephalic: but it should be remembered that many small filaments cross in front which are exposed to injury in venesection (Fig. 127).

Relation of Median Basilic Vein to Brachial Artery. — Since the median basilic vein is larger than the median cephalic, and, on account of the strong fascia beneath, more easily compressible, it is usually chosen for venesection; its position, therefore, in reference to the brachial artery, becomes important. The vein is only separated from the artery by the *semilunar fascia,* derived from the tendon of the biceps. This fascia is in some subjects remarkably thin. Sometimes the artery lies above the fascia, in contact with the vein. In choosing, there-

fore, this vein for venesection, there is a risk of wounding the artery; hence the practical rule, to bleed either from the median cephalic, or from the median basilic above the situation where it crosses the brachial artery.

Lymphatic Glands. — Immediately above the internal condyle, in the neighborhood of the basilic vein, we find one or two small *lymphatic glands*. Others may be found higher up along the inner side of the arm. A gland is occasionally met with at the bend of the elbow; but never below this joint. These little glands are the first which are liable to become tender and enlarged after a poisoned wound of the hand.

Muscular Fascia and its Connections. — The fascia which invests the muscles of the upper arm is a continuation of the fascia of the trunk and the axilla. This membrane varies in density: thus it is thin over the biceps, stronger on the inner side of the arm, to protect the brachial vessels and nerves, and strongest over the triceps. At the upper part of the arm it is connected with the coracoid process and the clavicle; it is strengthened at the axilla by an expansion from the tendons of the pectoralis major and latissimus dorsi; posteriorly, it is attached to the spine of the scapula. The fascia surrounds the brachial vessels with a sheath, and furnishes partitions which separate the muscles from each other. Of these partitions, the most marked are, the *external* and *internal intermuscular septa*, which divide the muscles on the anterior from those on the posterior surface of the upper arm. These septa are attached to the condylar ridges of the humerus and to the condyles. The *internal intermuscular septum*, the stronger of the two, begins at the insertion of the teres major, and is connected with the tendinous insertion of the coraco-brachialis; it separates the triceps extensor from the brachial anticus, to both of which it affords attachment to their muscular fibres. It is pierced by the ulnar nerve and the inferior profunda and anastomotic arteries. The *external intermuscular septum* commences from the insertion of the deltoid, and separates the brachialis anticus, the supinator longus, and the extensor carpi radialis longior in front, from the triceps extensor behind, to all of which muscles it affords attachment. It is pierced by the musculo-spiral nerve and the superior profunda artery.

At the lower part of the upper arm the fascia is remarkably strong, especially where it covers the brachialis anticus and the brachial vessels, and is continued over the muscles on the inner

side of the forearm. At the back of the elbow the fascia is attached to the tendon of the triceps and the olecranon.

Dissection. — Now remove the fascia corresponding to the incisions through the skin, in order to see the muscles on the front of the arm — namely, the biceps, the coraco-brachialis, and the brachialis anticus. The long, rounded muscle in front is the biceps; the muscle attached with it to the coracoid process is the coraco-brachialis; and the broad flat muscle covering the lower end of the humerus is the brachialis anticus.

Biceps. — The *biceps*, as its name implies, *arises* by two heads — a long and a short. The *short head arises* from the tip of the coracoid process of the scapula, by a thick, flat tendon in common with a slender muscle on its inner side, called the coraco-brachialis. The *long head arises* from the upper border of the glenoid fossa of the scapula and the glenoid ligament, by a long, rounded tendon, which, traversing the shoulder-joint, passes over the head of the humerus; there pierces the capsular ligament, and descends in the groove between the two tuberosities. The tendon is retained in the groove by a fibrous bridge derived from the capsule of the joint, and connected with the tendon of the pectoralis major. Divide this bridge, and see that the synovial membrane of the joint is reflected round the tendon and accompanies it for about two inches (*5 cm.*) down the groove, thus forming a synovial fold. The object of this is to facilitate the play of the tendon and to carry little arteries (from the anterior circumflex) for its supply. The two heads unite about the middle of the arm and form a single muscle, which terminates on a strong flat tendon of considerable length; this dips down into the triangular space at the bend of the elbow, and, after a slight twist upon itself, is *inserted* into the posterior part of the tubercle of the radius. The anterior part of the tubercle, over which the tendon plays, is crusted with cartilage, and a *bursa* intervenes to diminish friction. The most internal fibres of the muscle are inserted into a *strong, broad aponeurosis*, which is prolonged from the inner border of the tendon to the fascia on the inner side of the forearm. This aponeurosis, called the *semilunar fascia of the biceps*, protects the brachial vessels and the median nerve at the bend of the elbow (Fig. 128).

The *action* of the biceps is twofold. 1. It is a flexor of the forearm. 2. It is a powerful supinator of the forearm in consequence of its insertion into the *posterior* part of the tubercle

of the radius. Its power of supination is greatest when the forearm is half bent, because its tendon is then inserted at a right angle. Why does the long tendon pass through the shoulder-joint? It acts like a strap, and confines the head of the humerus in its proper centre of motion.* But for this tendon the head of the bone, when the deltoid acts, would be pulled directly upwards and strike against the under surface of the acromion. When the tendon is ruptured, or dislocated from its groove, a man can move his arm backwards and forwards, but he cannot raise the smallest weight. The biceps is *supplied* with *blood* by a branch from the brachial, which runs into the middle of its inner side, and divides into ascending and descending branches. Its *nerve* comes from the musculo-cutaneous.

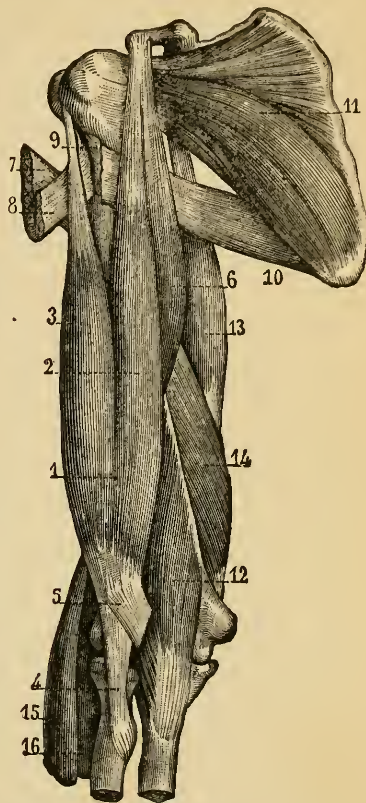


FIG. 128.—ANTERIOR MUSCLES OF THE ARM.

1. Biceps. 2. Short head of the biceps. 3. Long head of the same. 4. Tendon attached to the tuberosity of the radius. 5. Semilunar fascial aponeurosis of the biceps. 6. Coraco-brachialis. 7, 8. The two portions of the pectoralis major forming a groove with its concavity above. 9. Attachment of the latissimus dorsi. 10. Teres major. 11. Subscapularis. 12. Brachialis anticus. 13. Long head of the triceps. 14. Internal head of the triceps. 15. Supinator longus or brachio-radialis. 16. Extensor carpi radialis longior.

Coraco-Brachialis. — This thin muscle is situated at the upper part of the arm, and runs parallel to the inner border of the short head of the biceps. It *arises* by fleshy fibres from the point of the coracoid process, in common with the short head of the biceps, and from a fibrous septum which lies between them. The muscle descends backwards and outwards, and terminates on a flat tendon, which is *inserted* into the inner

* Another action of the long tendon of the biceps would seem to be that of an internal rotator of the humerus when that bone is rotated externally. The marked prominence of the internal tuberosity and the groove on its outer aspect would favor this view.

side of the middle of the humerus, between the brachialis anticus and the inner head of the triceps. Its *action* is to draw the humerus forwards and inwards — *e.g.*, in bringing the gun up to the shoulder. It is supplied by a branch from the musculo-cutaneous *nerve* which pierces it (Fig. 128).

Concerning the coraco-brachialis, remember: 1. That the musculo-cutaneous nerve runs through it; 2. That its inner fleshy border is the guide to the axillary artery in the last part of its course; 3. That the brachial artery lies upon its flat tendon of insertion, and can here be effectually compressed by the finger or the tourniquet.

The coraco-brachialis and biceps are covered at their upper part by the deltoid and pectoralis major. The head of the humerus rolls beneath the coraco-brachialis and short origin of the biceps; and a large *bursa* is interposed between these muscles and the tendon of the subscapularis, which covers the head of the bone.

Brachialis Anticus. — This broad muscle covers the lower half of the humerus, and is partially concealed by the biceps. Between the two muscles is the musculo-cutaneous nerve, which supplies them both.

It *arises* from the humerus by a fleshy digitation on either side of the tendon of the deltoid; from the lower half of the front and inner surfaces of the bone, and from the intermuscular septa. The muscle, becoming thicker and broader, covers the front of the capsule of the elbow-joint, to which it is more or less attached, and terminates on a tendon, which is *inserted* in a pointed manner into the anterior surface of the coronoid process of the ulna. Its *action* is to bend the forearm. Its *nerves* come from the musculo-cutaneous, and it usually receives in addition a small branch from the musculo-spiral (Fig. 121, p. 318).

Now examine the course and relations of the brachial vessels and nerves.

Course and Relations of the Brachial Artery. — The *brachial artery* — the continuation of the axillary — takes its name at the lower border of the teres major. It runs down the anterior and the inner side of the arm, along the *inner border of the coraco-brachialis and biceps*, to about an inch (*2.5 cm.*) below the elbow, where it divides, near the coronoid process of the ulna, into the radial and ulnar arteries.

Thus its direction corresponds with a line drawn from the deepest part of the axilla to the middle point between the condyles of the humerus.

In the upper part of its course it *lies on* the long and inner heads of the triceps (from the long head it is separated by the musculo-spiral nerve and superior profunda artery); in the middle, it lies on the tendon of the coraco-brachialis; in the lower part, on the brachialis anticus.

In *front* of the artery are the internal cutaneous nerve, the median basilic and basilic veins; the median nerve, which crosses obliquely over the artery, being on its outer side near the axilla, and on its inner side near the elbow; and lastly, the artery is more or less overlapped, in the first part of its course, by the coraco-brachialis, lower down by the fleshy belly of the biceps; the inner borders of these muscles, in their respective situations, being the best guides to the artery.

On the *outer side* of the artery are, the median nerve, the coraco-brachialis, and biceps.

On the *inner side* are, at first, the ulnar nerve, the internal cutaneous nerves; and, below, the median nerve.

The artery is accompanied by two veins (*venæ comites*) and the median nerve, all of which are invested in a common sheath of fascia.

The *ulnar nerve* runs along the inner side of the artery as far as the middle of the arm. Below this point, the nerve leaves the artery, and passes through the internal intermuscular septum to get behind the internal condyle.

About the middle of the humerus, the artery lies for nearly two inches (*5 cm.*) on the tendon of the coraco-brachialis, and is so close to the bone that it can be effectually compressed, provided the pressure be made in the proper direction — namely, outwards. Here, too, it is crossed by the median nerve.

At the bend of the elbow the artery is crossed by the semi-lunar fascia from the biceps. It enters a triangular space,* bounded by the pronator radii teres internally, and by the brachio-radialis externally. It sinks into this space, with the tendon of the biceps to its outer side, and the median nerve to its inner; all three rest upon the brachialis anticus. To compress the artery here, pressure should be made directly backwards. Opposite the coronoid process of the ulna it divides into the radial and ulnar arteries.

Two veins, of which the internal is the larger, lie in close contact with the brachial artery, and communicate at frequent intervals by transverse branches. Near the axilla they join and form the axillary vein.

* *Anticupital space.*

Branches of Brachial Artery. — The brachial artery gives off four branches, all from its inner side: namely, the superior profunda, the inferior profunda, the nutrient artery, and the anastomotica magna. It also distributes muscular branches to the coraco-brachialis and biceps, which are given off from its outer side.

a. The *profunda superior* arises from the inner and back part of the brachial artery, immediately below the tendon of the teres major.* It winds round the

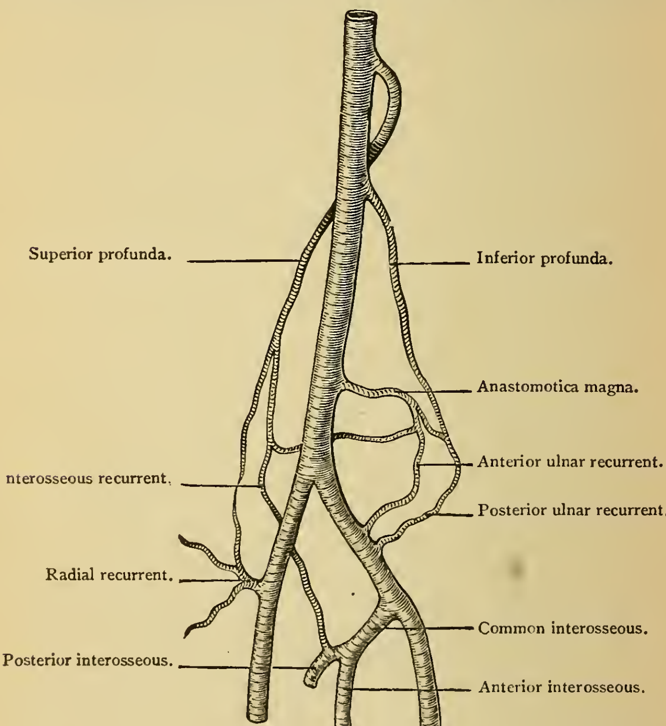


FIG. 129. — PLAN OF THE CHIEF BRANCHES OF THE BRACHIAL ARTERY AND THE ARTERIAL INOSCULATIONS ABOUT THE RIGHT ELBOW-JOINT.

back of the humerus, between the outer and inner heads of the triceps, accompanied by the musculo-spiral nerve, and, a little above the middle of the arm, divides into two branches, which run for some distance on either side of the nerve. One of these runs in the substance of the triceps muscle, with the nerve to the anconeous, as far as the olecranon, and anastomoses with the posterior ulnar

* If the profunda be not in its usual place, look for it above the tendon of the latissimus dorsi, where it will probably be given off from a common trunk with the posterior circumflex.

recurrent, the interosseous recurrent, and anastomotica magna arteries: the other branch accompanies the musculo-spiral nerve to the outer side of the arm, where it perforates the external intermuscular septum. It then descends deep in the interval between the brachialis anticus and supinator radii longus, and terminates in numerous ramifications, some of which pass in front of the external condyle, others behind it, to inosculate with the radial and interosseous recurrent arteries.

Before its division, the superior profunda sends several branches to the deltoid, coraco-brachialis, and the triceps, some of which inosculate with the circumflex. These assist in establishing a collateral circulation when the brachial artery is ligatured above the origin of the profunda.

b. The *profunda inferior* arises from the brachial, opposite to the insertion of the coraco-brachialis, or sometimes by a common trunk with the superior profunda. It runs with the ulnar nerve on the inner head of the triceps (which it supplies), passes through the internal intermuscular septum, and then descends to the interval between the internal condyle and the olecranon, inosculating with the posterior ulnar recurrent and anastomotica magna arteries. It also sends a small branch down in front of the internal condyle to anastomose with the anterior ulnar recurrent.

c. The *nutrient artery* of the humerus arises sometimes from the brachial, sometimes from the inferior profunda. It pierces the tendon of the coraco-brachialis, runs obliquely downwards through the bone, and in the medullary canal divides into ascending and descending branches, which anastomose with the nutrient vessels of the bone derived from the periosteum.

d. The *anastomotica magna* arises from the inner side of the brachial, about two inches (*5 cm.*) above the elbow, runs tortuously inwards, transversely across the brachialis anticus, and divides into branches, some of which pass in front of the internal condyle, anastomosing with the anterior ulnar recurrent artery; another passes behind the internal condyle by piercing the internal intermuscular septum, and anastomoses with the inferior profunda and posterior ulnar recurrent arteries; and one branch forms an arch, above the olecranon fossa, with the superior profunda.

e. Numerous *muscular branches* arise from the outer side of the brachial artery; one of these, the bicipital, more constant than the rest, supplies the biceps; another runs transversely beneath the coraco-brachialis and biceps, over the insertion of the deltoid, supplying this muscle and the brachialis anticus.

Venæ Comites. — The two veins which accompany the brachial artery are continuations of the deep radial and ulnar veins. The internal is usually the larger, and generally receives the veins corresponding to the principal branches of the artery. In their course they are connected at intervals by transverse branches either in front of, or behind, the artery. Near the subscapularis, the *vena comes externa* crosses obliquely in front of the axillary artery to join the *vena comes interna*, which then takes the name of axillary.

Now trace the great nerves of the upper arm, which proceed from the brachial plexus near the tendon of the subscapularis: namely, the median, the musculo-cutaneous, the ulnar, and the musculo-spiral nerves.

Median Nerve. — The *median nerve*, so called from the course it takes along the front of the arm and the forearm, arises by two roots, which converge in front of the axillary

artery (p. 322). The external root is derived from the outer cord, in common with the musculo-cutaneous; the internal from the inner cord, in common with the ulnar and internal cutaneous. In its course down the arm, the nerve is situated at first on the outer side of the brachial artery, between it and the coraco-brachialis; about the middle of the arm the nerve crosses obliquely over (in some cases under) the vessel, so that at the bend of the elbow it is found on the inner side of the artery, lying upon the brachialis anticus, and covered by the semilunar fascia from the biceps.*

As a summary of the distribution of the median nerve, we may say that it *supplies* the two pronators and all the flexors of the forearm (except the flexor carpi ulnaris and the ulnar half of the flexor profundus digitorum); the muscles of the ball of the thumb, the two radial lumbricales, both sides of the thumb, fore and middle fingers, and the radial side of the ring finger, on their palmar aspect (Fig. 130).†

Musculo-cutaneous Nerve. — This nerve (often called the external cutaneous or perforans Casserii) arises in common with the external root of the median from the external cord of the brachial plexus behind the pectoralis minor, and is situated on the outer side of the axillary artery. It perforates the coraco-brachialis obliquely, and then runs down between the biceps and the brachialis anticus to the outer side of the arm. A little above the elbow-joint, between the tendon of the biceps and the supinator radii longus, the nerve pierces the deep fascia and becomes subcutaneous; then, passing under the median cephalic vein, it divides into an anterior and a posterior branch, for the supply of the integuments of the forearm (Figs. 130, 131).

The musculo-cutaneous nerve, in the upper part of its course, sends branches to the coraco-brachialis and the short head of

* I have observed the following *varieties* relating to the median nerve, and its course in regard to the artery: —

a. The roots may be increased in number by one on either side of the artery; or the internal root may be deficient.

b. They may vary in their position with regard to the artery; both may be situated behind the vessel; or one behind, and the other in front of it.

c. The nerve, formed in the usual manner, may be joined lower down by a large branch from the external cutaneous; such a case presents a junction of two large nerves in front of the brachial artery, in the middle of the arm.

d. The nerve in many cases crosses under, instead of over, the artery.

e. The nerve sometimes runs parallel and external to the artery; or it may run parallel to, and in front of, the artery.

† It sends two filaments to the elbow-joint, which do not supply any structure in the arm. — A. H.

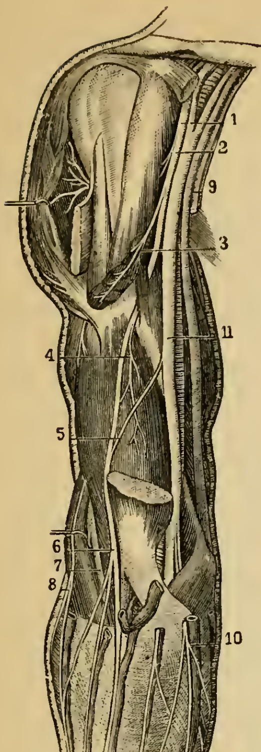


FIG. 130. — BRACHIAL PORTION OF MUSCULO-CUTANEOUS MEDIAN AND ULNAR NERVES.

1. Musculo-cutaneous. 2. Branch of the same to the coraco-brachialis muscle. 3. Branch which supplies the biceps. 4. Branch to brachialis anticus muscle. 5. Anastomosing branch which it receives from the median. 6. Branch of the nerve at the point where it pierce· the aponeurosis of the arm. 7. Radial nerve as it passes between the brachial anticus and supinator longus, or brachio-radialis. 8. External cutaneous branch from the radial. 9. Divided trunk of the internal cutaneous. 10. Anterior or ulnar branch of the internal cutaneous. 11. Brachial portions of the median and ulnar nerves.

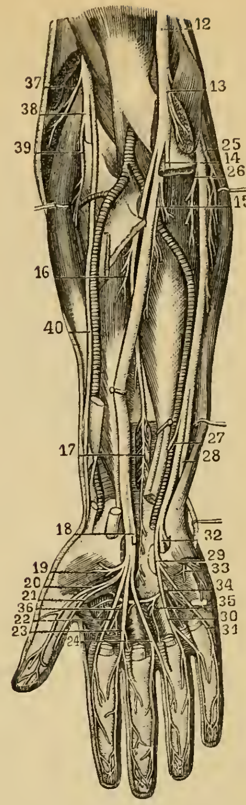


FIG. 131. — TERMINAL PORTION OF THE MEDIAN AND ULNAR NERVES.

12. Forearm, palmar, and digital portions of these nerves. 13. Branch to the pronator radii teres muscle. 14. Anterior muscular branches divided and removed. 15. Branch to the flexor profundus digitorum. 16. Branch to the flexor longus pollicis. 17. Branch to the interosseous membrane. 18. Palmar (cutaneous) branch divided below its origin. 19. To the thenar eminence. 20. External lateral branch of the thumb. 21. Internal lateral branch of the same. 22. External digital branch to the index finger. 23. Common trunk to the index and middle fingers. 24. Digital branches from the median to the middle finger and the thumb side of the ring finger. 25. Ulnar nerve. 26. Branch of the same nerve to the flexor profundus digitorum. 27. Cutaneous and anastomosing filament from the ulnar. 28. Dorsal branch of this nerve. 29. Superficial palmar branch. 30. Common trunk for the ring and little fingers. 31. Digital branch to the internal side of the little finger. 32. Deep palmar branch. 33. Branches from the preceding to the hypothenar eminence. 34. Branches to the fourth interosseous and fourth lumbricales. 35. Branches to the same in the

Fig. 131, *continued.*

third. 36. Branches to the adductor pollicis and the muscles of the first and second interosseous spaces. 37, 38, 39, 40. Branches of radial.

the biceps, and, as it descends between the biceps and the brachialis anticus, it supplies both. Consequently, if the nerve were divided in the axilla, the result would be inability to bend the arm.*

In one hundred arms the relative position of the nerve to the artery in its course down the arm was as follows: —

In 72, the nerve took the ordinary course.
" 20, the nerve crossed obliquely under the artery.
" 5, the nerve ran parallel and superficial to the artery.
" 3, the nerve ran parallel and external to the artery.

These varieties of the median nerve are of practical importance, for this reason: Whenever in the operation of tying the brachial artery we do not find the nerve in its normal position, we may expect to find some irregular distribution of the arteries — *e.g.*, a high division of the brachial, or even, which I have often seen, a 'vas aberrans' coming from the upper part of the brachial, and joining either the radial or ulnar arteries.

Ulnar Nerve. — This nerve arises from the inner cord of the brachial plexus, in common with the internal cutaneous and the inner head of the median. It descends along the inner side of the brachial artery, as far as the insertion of the coraco-brachialis. The nerve then diverges from the artery, running obliquely over the inner head of the triceps, perforates the internal intermuscular septum, and runs with the inferior profunda artery, behind the internal condyle (Figs. 130, 131).

The *distribution* of the *nerve* is to the elbow-joint, to the flexor carpi ulnaris, to half the flexor profundus digitorum, to all the interosseous muscles of the hand, to both sides of the little finger, to the ulnar side of the ring finger, on their dorsal and palmar aspects, to the muscles of the ball of the little finger, to the wrist-joint, to the two ulnar lumbricales, and, lastly, to the adductor pollicis, and the inner head of the flexor brevis pollicis.

Previous to the examination of the musculo-spiral nerve we should examine the great muscle which occupies the whole of the posterior part of the humerus — viz., the triceps extensor cubiti.

* In some instances the musculo-cutaneous nerve descends on the inner side of the coraco-brachialis without perforating the muscle; in these cases it often sends a larger branch than usual to the median nerve.

The trunk of the musculo-cutaneous nerve may come from the median at any point between the axilla and the middle of the arm. In some subjects the nerve is absent; all its branches are then supplied by the median, which is larger than usual. Such anomalies are easily explained by the fact of the two nerves having a common origin.

Triceps Extensor Cubiti. — This muscle has three distinct origins, named, from their position, the *external*, the *internal*, and the *middle* or *long* heads; the *middle* or *long* head *arises* by a flat tendon from the axillary border of the scapula, close to the glenoid cavity, and in connection with the glenoid and capsular ligaments. The *external* head *arises* from the humerus, beginning in a pointed form immediately below the insertion of the teres minor, from the posterior surface between this and the musculo-spiral groove, and from the external intermuscular septum. The *internal* head *arises* from the humerus below the insertion of the teres major, from the posterior surface of the bone below the musculo-spiral groove and from the internal intermuscular septum. The three heads unite, near the middle of the arm, to form a single fleshy mass, which covers the posterior part of the elbow-joint, and is *inserted* by a thick tendon into the summit and sides of the olecranon. There is a bursa between the tendon and the olecranon, which is sometimes multilocular. Each head is supplied by a separate branch from the musculo-spiral nerve.*

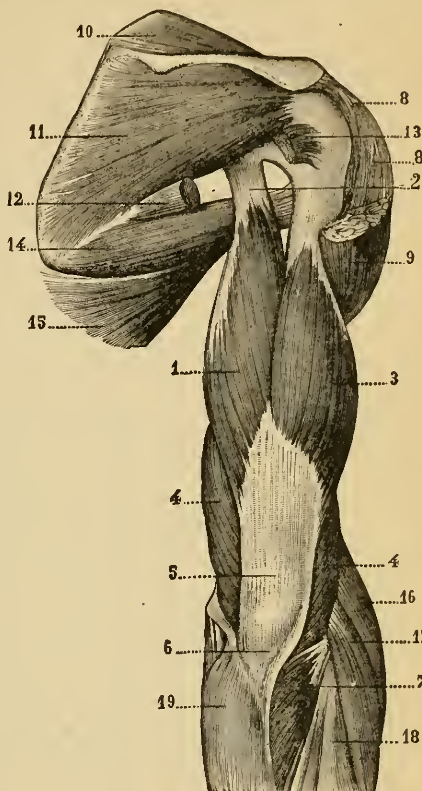


FIG. 132.—TRICEPS MUSCLE.

1. Triceps. 2. Long head of the triceps. 3. Outer head. 4. Inner head. 5. Tendon of the triceps. 6. Its attachment to the olecranon. 7. Anconeus, the fibres of which follow those of the outer head of the triceps. 8, 8. Superior part of the deltoid; the posterior half has been excised. 9. Its inferior part. 10. Supra-spinatus. 11. Infra-spinatus. 12. Origin of the teres minor. 13. Insertion of the teres minor. 14. Teres major. 15. Superior extremity of the latissimus dorsi. 16. Supinator longus or brachio-radialis. 17. Extensor carpi radialis longior. 18. Extensor carpi ulnaris. 19. Flexor carpi ulnaris.

* The *subanconeus*, a small muscle situated beneath the triceps, will be described later on.

Musculo-spiral Nerve. — This, the largest of the brachial nerves, arises, in common with the circumflex, from the posterior cord of the brachial plexus (p. 322). It descends at first behind the third portion of the axillary artery, and then behind the brachial artery; it subsequently winds obliquely round the posterior part of the humerus, between the external and internal heads of the triceps, in company with the superior profunda artery. About the lower third of the outer side of the arm the nerve perforates the external intermuscular septum, and then runs deeply embedded between the brachialis anticus and the supinator radii longus (or brachio-radialis).

The nerve gives off branches on the *inner* side of the humerus, to the inner and long heads of the triceps, and the internal cutaneous branch; on the *back* of the humerus, to the external head of the triceps and the anconeus; on the *outer* side of the humerus, to the supinator radii longus (or brachio-radialis), the extensor carpi radialis longior, and the brachialis anticus (usually); lastly, after perforating the septum, it gives off the upper and lower external cutaneous branches.

A little above the elbow-joint the nerve divides into two principal branches—the *radial*, which accompanies the radial artery along the forearm, and the *posterior interosseous*, which perforates the supinator brevis, and supplies the muscles on the back of the forearm.

To sum up the muscular *distribution* of this *nerve*, we may say that it supplies *all* the extensors of the forearm, wrist, thumb, and fingers; and *all* the supinators except one — namely, the biceps (supplied by the musculo-cutaneous nerve).

DISSECTION OF THE FRONT OF THE FOREARM

Surface Marking. — The front of the forearm presents, at the bend of the elbow, a triangular depression, from which there extends down to the wrist a groove which corresponds to the radial artery; on the inner side is another groove, increasing in depth towards the wrist, indicating the course of the ulnar artery. The head of the radius can be easily felt on the outer side, below the external condyle of the humerus, and in the lower third the bone becomes again defined, terminating below in the styloid process, beyond which is the prominence of the tubercle of the scaphoid. The border of the ulna can be felt on

the inner side of the forearm, in the lower half, and it ends at the wrist in an ill-defined styloid process, which does not descend as low as the corresponding process of the radius. The lower part of the forearm presents, an inch (*2.5 cm.*) beyond the wrist-joint, a transverse furrow, which corresponds with the border of the annular ligament.

Dissection. — Prolong the incision down to the wrist, and, at its termination, make another transversely. Reflect the skin, and dissect the subcutaneous veins and nerves.

Cutaneous Veins. — On the inner side is the *anterior ulnar vein*, which commences on the front of the wrist, and is then continued upwards on the inner side of the forearm as far as the elbow, where it is joined by the posterior ulnar vein to form the common ulnar vein. This vein communicates with the median vein by numerous branches (p. 328).

The veins on the back of the hand commence at the extremities of the fingers, run up *between* the knuckles, and unite on the back of the hand, forming an arch with its concavity upwards. The *posterior ulnar vein* arises from this arch by a branch (vena salvatella) situated over the fourth interosseous space, and runs up on the back of the forearm, towards the inner condyle, to join the anterior ulnar vein.

The *radial vein*, situated on the outer side of the forearm, commences on the back of the hand from the venous arch, runs up the radial side of the front of the forearm to the elbow, where, after receiving the median cephalic, it becomes the cephalic vein.

Running up in front of the middle of the forearm is the *median vein;* it communicates in the forearm with the radial and anterior ulnar veins, and near the bend of the elbow it is joined by a deep branch — *mediana profunda* — after which it divides into two branches, an outer or *median cephalic*, which joins the cephalic, and an inner or *median basilic*, which joins the basilic (Fig. 127, p. 327).

Cutaneous Nerves. — On the radial side of the forearm, as low down as the wrist, are found the terminal filaments of the *anterior branch* of the musculo-cutaneous nerve, which, about the middle of the forearm, sends a *posterior branch* backwards to supply the posterior and lower part of the forearm as low as the wrist, communicating with the radial and external cutaneous branch of the musculo-spiral. At the lower part of the front of the forearm, one or more of these filaments are situated over

the radial artery, and one branch passes to the palm to supply the skin over the muscles of the ball of the thumb ; it communicates with the palmar branch of the median and with the radial nerve.

In front of the upper part of the forearm are some filaments of the *external cutaneous branch* of the musculo-spiral nerve ; on the outer and back part of the forearm, near the elbow, the lower *external cutaneous branch* of the musculo-spiral runs down as far as the wrist to supply the skin.

At the lower third of the radial side of the forearm, the *radial nerve* becomes superficial, and turns over the radius to supply the back of the hand and fingers.

On the ulnar side the *anterior division* of the internal cutaneous nerve descends as far as the wrist, its *posterior branch* passing the back of the forearm to supply it as far as the middle. Near the styloid process of the ulna, the *dorsal branch* of the ulnar nerve perforates the fascia to reach the back of the hand.

Deep Fascia of the Forearm. — The muscles of the forearm are enveloped by a dense shining aponeurosis, continuous with that of the arm. Its thickness increases towards the wrist, that the tendons, in this situation, may be kept in their position. It is composed of fibres which cross each other obliquely, and is attached, above, to the condyles of the humerus and olecranon ; internally, to the ridge on the posterior part of the ulna. At the back of the wrist it forms the posterior annular ligament, and in front it is continuous with the anterior annular ligament. Above, the fascia is strengthened by fibres from the tendons of the biceps and brachialis anticus. The aponeurotic expansion from the inner edge of the tendon of the biceps is exceedingly strong. It braces the muscles on the inner side of the forearm, and interlaces at right angles with the fibres of the fascia attached to the internal condyle. The under surface of the fascia gives origin to the muscular fibres in the upper part of the forearm, and furnishes septa which separate the muscles, and form surfaces for their origin. The fascia is perforated at various parts for the passage of the cutaneous vessels and nerves of the forearm.

Dissection. — Remove the fascia from the muscles by incisions corresponding to those for reflecting the skin, taking care of the cutaneous branches of the median and ulnar nerves close to the wrist.

Triangle at the Elbow. — At the bend of the elbow is a triangular space,* with its base towards the humerus; on the inner side this space is bounded by the pronator teres; on the outer, by the supinator radii longus or brachio-radialis. In it are the following objects which must be carefully dissected: 1, In the centre is the brachial artery (with its companion veins) dividing into the radial as its outer, and into the ulnar as its inner branch; 2, on the outer side of the artery is the tendon of the biceps; 3, on the inner side is the median nerve; 4, the musculo-spiral nerve on the outer side is partly concealed by the supinator longus or brachio-radialis; 5, the radial recurrent artery; 6, the anterior ulnar recurrent; 7, the common interosseous branch of the ulnar artery; 8, the vena mediana profunda.

Muscles of the Forearm. — The muscles of the forearm are arranged in two groups: one, consisting of supinators and extensors, is attached to the outer condylar ridge and condyle; the other, consisting of pronator and flexors, is attached to the inner condyle. The inner group should be examined first. They arise by a common tendon, and are arranged in the following order: pronator teres; flexor carpi radialis; palmaris longus; flexor sublimis digitorum, and flexor carpi ulnaris.

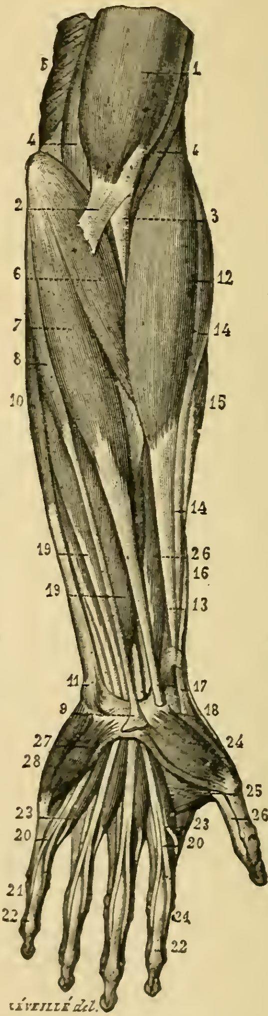
Pronator Radii Teres. — This muscle forms the inner boundary of the triangular space at the elbow. It *arises* by two heads; *one*, from the anterior surface of the internal condyle, from the common tendon, from the fascia of the forearm, and from the septum between it and the flexor carpi radialis; the *other*, by a small tendinous origin from the inner border of the coronoid process of the ulna. From these two origins, between which the median nerve passes, the muscle proceeds obliquely downwards and outwards across the forearm, and is *inserted* by a flat tendon into a rough surface on the outer and back part of the middle third of the radius. In amputating the forearm it is very desirable to save the insertion of this muscle, that the stump may have a pronator. Its *nerve* comes from the median (Fig. 133).

Flexor Carpi Radialis. — This muscle, situated on the ulnar side of the preceding muscle, *arises* by the common tendon from the internal condyle, from the intermuscular septa, and from the fascia of the forearm. The fleshy fibres terminate a little above the middle of the forearm, in a flat tendon, which

* *Anticupital space.*

runs in a separate sheath outside the anterior annular ligament of the wrist, passes through a groove in the os trapezium, bridged over by fibrous tissue and lined by a synovial membrane,

1. Inferior part of the biceps.
2. Aponeurosis of the biceps.
3. Tendon by which it is attached to the bicipital tuberosity of the radius.
4, 4. Brachialis anticus.
5. Internal head of the triceps.
6. Pronator radii teres.
7. Flexor carpi radialis.
8. Palmaris longus.
9. Inferior extremity of this muscle expanding into the palmar fascia.
10. Flexor carpi ulnaris.
11. The attachment to the pisiform bone.
12. Supinator longus or brachio-radialis.
13. Inferior attachment of this muscle.
14, 14. Extensor carpi radialis longior.
15. Extensor carpi radialis brevior.
16. Extensor ossis metacarpi pollicis.



17. Tendon of the same inserted into the metacarpal bone.
18. Tendon of the extensor secundi internodii pollicis.
19, 19. Flexor sublimis digitorum.
20, 20. Tendons of insertion dividing to allow the tendons of the flexor profundus digitorum to pass to their insertion.
21, 21. Insertion of the flexor sublimis digitorum to the lower part of the middle phalanges.
22, 22. Attachment of the flexor profundus digitorum to the distal phalanges.
23, 23. Lumbricales.
24. Abductor pollicis.
25. Its attachment to the proximal phalanx of the thumb.
26, 26. Flexor longus pollicis.
27. Flexor brevis digitorum.
28. Abductor minimi digiti.

FIG. 133.—SUPERFICIAL MUSCLES ON THE ANTERIOR SURFACE OF THE LEFT FOREARM.

and is *inserted* into the base of the metacarpal bone of the index finger. The outer border of its tendon is the guide to the radial

artery in the lower half of the forearm. Its *nerve* comes from the median* (Fig. 133).

It acts as a flexor of the wrist, including not only the joint proper, but also the carpo-metacarpal joints. Slight pronation can be excited when the hand is thoroughly supined. (A. H.)

Palmaris Longus. — This slender muscle *arises* from the common tendon at the internal condyle, from the intermuscular septum, and from the fascia of the forearm. About the middle of the forearm it terminates in a flat tendon, which descends along the middle of the forearm to the wrist, lying upon the flexor sublimis digitorum; it then passes over the anterior annular ligament, and is continued into the palmar fascia. This muscle is a tensor of the palmar fascia.† Its nerve comes from the median (Fig. 133).

Flexor Carpi Ulnaris. — This muscle *arises* by two heads: *one* from the internal condyle, the common tendon, and the intermuscular septum; the *other* from the inner edge of the olecranon: these two origins form an arch, under which the ulnar nerve and the posterior ulnar recurrent artery pass. It also *arises* from the upper two-thirds of the posterior edge of the ulna, through the medium of the aponeurosis, which is common to this muscle, the flexor profundus digitorum, and the extensor carpi ulnaris. The tendon appears on the radial side of the muscle, about the lower third of the forearm, and receives fleshy fibres on its ulnar side as low as the wrist. It is *inserted* into the pisiform bone, and thence by a strong tendon into the unciform and the base of the fifth metacarpal bone. Its *nerve* comes from the ulnar (Fig. 133).

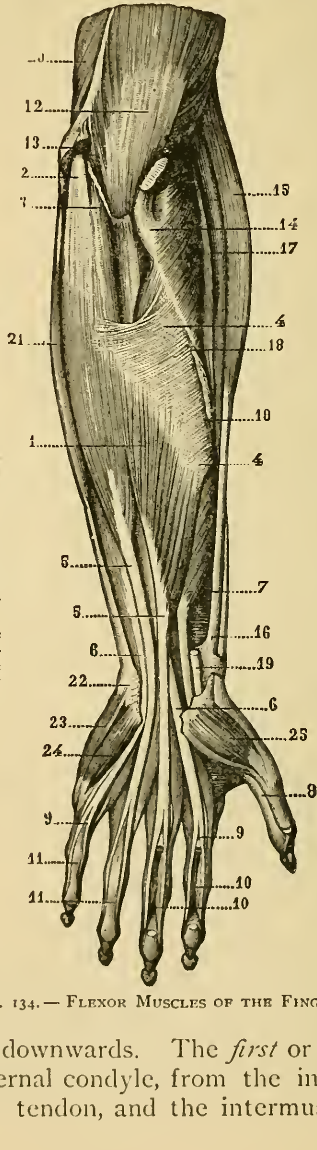
The tendon of the flexor carpi ulnaris is the guide to the ulnar artery, which lies close to its radial side, and is *overlapped* by it. As it passes over the annular ligament, the tendon furnishes a fibrous expansion to protect the ulnar artery and nerve. Its *action* is as a flexor of the wrist. It will straighten the hand when abducted; *i.e.*, slight-adductor.

Flexor Sublimis Digitorum. — This muscle has three dis-

* A muscle is not infrequently found beneath this muscle, called by Mr. Wood the flexor carpi radialis brevis, or profundus. It arises from the front of the radius above the pronator quadratus, and is inserted into the base of the metacarpal bone of the middle finger. (*Journ. of Anat. and Phys.*, p. 55, Nov. 1866.)

† The palmaris longus is absent in about one out of ten subjects. The situation of its muscular portion is subject to variation, sometimes occupying the middle, sometimes the lower third of the forearm. The tendon is in some instances wholly inserted into the anterior annular ligament.

tinct origins, and is situated beneath those previously mentioned, so that, in order to expose it fully, the preceding muscles should be reflected by cutting them through the middle, and turning the



1. Flexor sublimis digitorum.
2. Its origin from the internal condyle.
3. Its origin from the coronoid process.
4, 4. Its origin from the radius.
5, 5. Its two superficial tendons to the middle and ring fingers.
6, 6. Its two deep tendons to the index and little fingers.
7. Flexor longus pollicis.
8. Tendon of this muscle.
9. Bifurcation of the tendons of the flexor longus digitorum.
10, 10. Groove made by these tendons.
11, 11. Tendons of the flexor profundus digitorum occupying these grooves and filling them up.
12. Brachialis anticus tendon.
13. Internal condyle of the humerus.
14. Biceps tendon.
15. Supinator longus or brachio-radialis.
16. Its attachment to the styloid process of the radius.
17. Extensor carpi radialis longior.
18. Tendon of insertion of the pronator radii teres.
19. Tendon of insertion of the flexor carpi radialis.
20. Triceps.
21. Flexor carpi ulnaris.
22. Its attachment to the pisiform bone.
23. Abductor minimi digiti.
24. Flexor brevis minimi digiti.
25. Abductor pollicis.

Fig. 134.— Flexor Muscles of the Fingers.

ends upwards and downwards. The *first* or *longer origin* takes place from the internal condyle, from the internal lateral ligament, the common tendon, and the intermuscular septum ; the

second origin takes place from the coronoid process o. the ulna above the pronator teres; the *third origin*, by tendinous and fleshy fibres from the oblique ridge on the front of the radius, extending from the tubercle to about an inch (*2.5 cm.*) below the insertion of the pronator teres. This third, called its *radial origin*, is partly concealed by the pronator teres. The muscle, thus formed, passes down the middle of the forearm, and divides into four distinct muscular slips; from these, four tendons arise, which pass beneath the annular ligament, arranged in two pairs, the tendons of the middle and ring fingers being placed over those of the fore and little fingers. The tendons pass through the palm to the fingers, where they diverge and split to allow the passage of the deep flexor tendons, and are *inserted* into the sides of the second phalanges where they will be subsequently traced. Its *action* is, therefore, to bend the second joint of the fingers and continuing its contraction will assist to flex the wrist (Fig. 134).

The muscles described as *arising* from the internal condyle are all supplied by the median nerve, except the flexor carpi ulnaris, which is supplied by the ulnar.

Having finished the superficial muscles on the inner side of the forearm, notice one of those on the outer side, named supinator radii longus, before tracing the vessels and nerves of the forearm.

Supinator Radii Longus, or Brachio-radialis. — This muscle forms the external boundary of the triangular space* at the bend of the elbow. It *arises* by fleshy fibres from the upper two-thirds of the external condylar ridge of the humerus, commencing a little below the insertion of the deltoid, and from the external intermuscular septum. The muscular fibres terminate about the middle of the forearm in a flat tendon, which is *inserted* into the outer side of the base of the styloid process of the radius. The inner border of the muscle is the guide to the radial artery, which lies between this muscle and the flexor carpi radialis. It supinates the hand, but *acts* much more powerfully as a flexor of the forearm. It is *supplied* by the musculo-spiral nerve (Fig. 134).

Radial Artery. — The radial artery, the smaller division of the brachial, runs down the radial side of the forearm to the wrist, where it turns over the external lateral ligament of the carpus, beneath the extensor tendons of the thumb, and sinks

* *Anticupital space.*

into the angle between the first and second metacarpal bones to form the deep palmar arch. Thus, its *course* corresponds with a line drawn from the middle of the bend of the elbow to the front of the styloid process of the radius.

In the upper third of the forearm, the artery lies deep between the pronator teres on the inner and the brachio-radialis on the outer side; the fleshy border of the latter overlaps it in muscular subjects. In the lower two-thirds of the forearm the artery is more superficial, and is placed between the tendons of the brachio-radialis on the outer and the flexor carpi radialis on the inner side. In its course, it lies successively on the following: first, upon the tendon of the biceps; secondly, upon the supinator radii brevis; thirdly, upon the insertion of the pronator teres; fourthly, upon the radial origin of the flexor sublimis; fifthly, upon the flexor longus pollicis; sixthly, upon the pronator quadratus, and lastly, upon the lower end of the radius. The artery then turns round the outer side of the wrist-joint, lying upon the external lateral ligament, and covered by the tendons of the extensores ossi metacarpi and extensor brevis pollicis or primi internodii pollicis, some cutaneous veins, and branches of the radial nerve; next, it lies upon the trapezium; it is then crossed by the extensor longus pollicis or secundi internodii pollicis; and, lastly, passing between the two heads of the first dorsal interosseous muscle, it enters the palm to form the deep palmar arch. It is accompanied by two veins, which communicate at frequent intervals, and join the venæ comites of the brachial artery at the bend of the elbow.

In the middle third of its course the artery is accompanied by the radial nerve (a branch of the musculo-spiral), which lies to its outer side. Below this point, the nerve leaves the artery and passes, under the tendon of the brachio-radialis, to the back of the hand.

Thus, in the situation where the pulse is usually felt, the radial nerve no longer accompanies the artery; nevertheless, the vessel is accompanied by a branch of the musculo-cutaneous (or external cutaneous), which lies superficially to it.

The radial artery sends off in the forearm the following branches, besides offsets, which supply the muscles on the outer side of the forearm —

a. The *radial recurrent* is given off just below the elbow; it ascends upon the supinator brevis, between the brachio-radialis and the brachialis anticus, to supply the long and short supinators and the two radial extensors. It runs up with the

musculo-spiral nerve, and forms a delicate inosculation with the superior profunda (Fig. 129, p. 334).

b. The *muscular branches* which are given off to the muscles on the outer side of the forearm.

c. The *arteria superficialis volæ* arises from the radial, about half an inch (*13 mm.*) or more above the lower end of the radius; it runs over the anterior annular ligament, above or through the origin of the muscles of the ball of the thumb, into the palm of the hand, where it sometimes inosculates with the superficial branch of the ulnar, and completes the superficial palmar arch.* †

d. The *anterior carpal* artery is a small branch of the radial, which arises close to the lower border of the pronator quadratus, and then runs beneath the tendons, and supplies the anterior surface of the synovial membrane and bones of the carpus, anastomosing with the anterior interosseous, the anterior carpal branch of the ulnar, and the recurrent carpal branch of the deep palmar arch.

At the wrist it gives off —

e. The *posterior carpal* artery, which runs beneath the extensor tendons, and joins the corresponding branch of the ulnar to form an arch; it also anastomoses with the anterior interosseous artery on the back of the wrist.

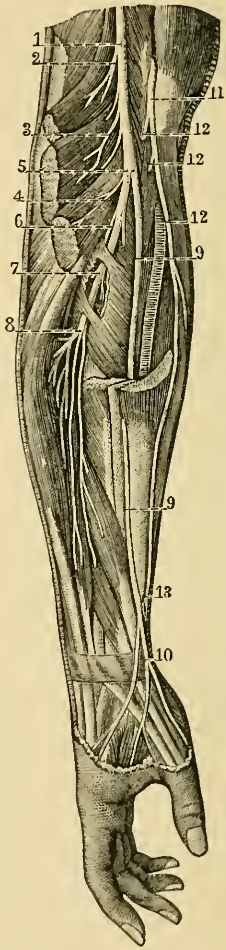
Radial Nerve. — The *radial nerve*, a branch of the musculo-spiral, is given off above the bend of the elbow, deep between the brachio-radialis and brachialis anticus; it descends on the outer side of the radial artery, covered by the brachio-radialis. In the *upper* third of the forearm, the nerve is at some distance from the artery; in the *middle* third, it approaches nearer to it, lying to its outer side; but in the *lower* third, the nerve leaves the artery, passes underneath the tendon of the brachio-radialis, perforates the deep fascia on the outer side of the forearm, and becomes subcutaneous. It then divides into two branches: an *outer*, the smaller, which supplies the skin of the ball of the thumb, and communicates with the anterior branch of the musculo-cutaneous nerve; and an *inner*, which generally supplies both sides of the dorsal aspects of the thumb, of the index and middle fingers, and of the radial side of the ring finger.

Ulnar Artery. — This artery, the larger of the two divisions of the brachial, comes off below the elbow, runs obliquely inwards along the ulnar side of the forearm to the wrist, passes over the annular ligament near the pisiform bone, and, entering the palm, forms the superficial palmar arch, by inosculating with the superficialis volæ (Fig. 129, p. 334).

* There is great variety in the size and origin of the superficialis volæ; sometimes it is very large, arises higher than usual, and runs to the wrist parallel with the radial; sometimes it is very small, terminating in the muscles of the thumb; or it may be absent.

† When this artery arises from the radial two inches (*5 cm.*) or more above the distal end of the radius, it continues parallel with the radial artery, thus producing the condition known as *double pulse.* (A. H.)

In the upper half of its *course* the artery describes a gentle curve with the concavity towards the radius, and lies deep beneath the superficial layer of muscles, namely, the pronator



1. Trunk of the radial nerve.
2. Its branch to brachio-radialis.
3. Its branch to extensor carpi radialis longior.
4. Its branch to extensor carpi radialis brevior.
5. Bifurcation of the trunk.
6. Posterior or muscular branch.
7. The same branch traversing the supinator brevis and supplying it.
8. Terminal filaments of this division.
9, 9. Anterior or cutaneous branch of this nerve.
10. Termination of this branch.
11. Musculo-cutaneous n.
12. Its terminal divisions.
13. Anastomosing branch with the cutaneous division of the radial

FIG. 135.—TERMINAL BRANCHES OF THE RADIAL NERVE.

teres, flexor carpii radialis, palmaris longus, and flexor sublimis digitorum. It is also crossed in its upper part by the median nerve. In the lower part of its course it comes nearer the sur-

face, and descends between the flexor sublimis and flexor carpi ulnaris, of which the tendon partially overlaps it at the wrist. The artery lies for a short distance on the brachialis anticus; in the remainder of its course it lies on the flexor profundus digitorum.

The ulnar nerve is at first separated from the artery by a considerable interval; about the middle of the forearm it joins the artery, and accompanies it in the rest of its course, lying close to its inner side. Both pass over the anterior annular ligament of the carpus, lying close to the pisiform bone, — the nerve being nearer to the ulnar side and a little behind the artery. A strong expansion from the tendon of the flexor carpi ulnaris protects them in this exposed situation.

Observe that the ulnar artery, in the lower third of its course, lies under the radial border of the tendon of the flexor carpi ulnaris, which is the *surgical guide* to the vessel. The artery is accompanied by two veins, which join the venæ comites of the brachial.

The ulnar artery gives off the following branches in the forearm: —

a. The *anterior and posterior ulnar recurrent arteries* arise immediately below the elbow-joint — sometimes by a common trunk. The *anterior* passes upwards between the brachialis anticus and the pronator teres, and inosculates with the inferior profunda and anastomotica magna. The *posterior*, the larger, ascends between the flexor sublimis and the flexor profundus digitorum, to the space between the internal condyle and the olecranon: it then passes up between the two heads of the flexor carpi ulnaris, where it inosculates with the inferior profunda, the anastomotica magna, and, above the olecranon, with the posterior interosseous recurrent (Fig. 129, p. 334).

b. The *common interosseous* artery is about half an inch (*12.5 mm.*) long. It arises from the ulnar, just below the tubercle of the radius, and soon divides into the anterior and posterior interosseous, which we shall examine presently.

c. The *muscular branches*, which supply the muscles on the ulnar side of the forearm.

d. The *carpal branches* are given off just above the pisiform bone; the *posterior carpal* runs beneath the tendon of the flexor carpi ulnaris and the extensor tendons, and forms, with the corresponding branch of the radial artery, an arch, from which are usually given off the second and third dorsal interosseous arteries: these anastomose with the perforating arteries. The *anterior carpal* runs in front of the carpus, beneath the flexor tendons, supplies the synovial membrane and the ligaments, and anastomoses with the anterior carpal from the radial.

Ulnar Nerve.* — This nerve runs behind the internal condyle, between two origins of the flexor carpi ulnaris. In its course down the ulnar side of the upper part of the forearm, the

* The ulnar nerve, like the median, is only distributed to structures below the elbow-joint. — A. H.

nerve is still covered by this muscle, and lies upon the flexor profundus digitorum. About the middle of the forearm, the nerve joins the ulnar artery, and runs along its inner side over the anterior annular ligament into the palm (Fig. 131, p. 337).

The ulnar nerve gives off the following branches: —

a. The *articular branches* to the joint are given off to it, immediately behind the elbow.

b. The *muscular branches* are distributed to the flexor carpi ulnaris and the ulnar half of the flexor profundus digitorum, and are given off from the ulnar a short distance below the elbow.

c. A *cutaneous branch* is given off about the middle of the forearm, one filament of which, called the *palmar cutaneous branch*, accompanies the ulnar artery to the palm, and communicates with branches from the median nerve.

d. The *dorsal cutaneous branch*, of considerable size, is given off from the ulnar about two inches above the styloid process of the ulna to pass to the back of the hand. It crosses under the tendon of the flexor carpi ulnaris, pierces the deep fascia, and, immediately below the styloid process of the ulna, appears on the back of the hand, where it divides into branches which supply the back of the little finger and half of the ring finger; here also it sends a branch which communicates with the corresponding branch of the radial nerve.

e. *Articular branches* are also distributed to the wrist-joint.

Median Nerve. — This nerve, at the bend of the elbow, lies on the inner side of the brachial artery and beneath the bicipital fascia. It then passes between the two heads of origin of the pronator teres, and descends along the middle of the forearm, between the flexor sublimis and the flexor profundus digitorum. At the lower part of the forearm, it becomes more superficial, lying above the wrist between the outer tendon of the flexor sublimis and the inner border of the tendon of the flexor carpi radialis; beneath, or to the ulnar side of the palmaris longus, and having in front of it the skin and deep fascia; it then enters the palm beneath the anterior annular ligament, and divides into five branches for the supply of the thumb, both sides of the fore and middle fingers, and the radial side of the ring finger (Fig. 131, p. 337).

Immediately below the elbow, the median nerve sends off: —

a. The *muscular branches* to the pronater teres, and to all the flexor muscles of the forearm, except the flexor carpi ulnaris and the ulnar half of the flexor profundus, which are supplied by the ulnar nerve.

b. The *anterior intcrosseous nerve*, also a branch of the median, runs with the anterior interosseous artery on the interosseous membrane, lying on its radial side, between the flexor longus pollicis and flexor profundus digitorum; it supplies both these muscles and the pronator quadratus.

c. The *palmar cutaneous branch* is given off from the median before it passes beneath the annular ligament. This branch passes over the ligament and divides into numerous filaments to supply the skin of the palm and the ball of the thumb, communicating with the cutaneous palmar branches of the ulnar, the external cutaneous, and the radial nerves.

Dissection. — Now reflect the superficial layer of muscles to see those more deeply seated. Preserve the principal vessels and nerves.

The deep-seated muscles are, on the ulnar side, the flexor digitorum profundus; and, on the radial side, the flexor longus pollicis; beneath both, near the wrist, lies a transverse muscle, the pronator quadratus. On the interosseous membrane, between the first two named muscles, run the anterior interosseous artery and nerve.

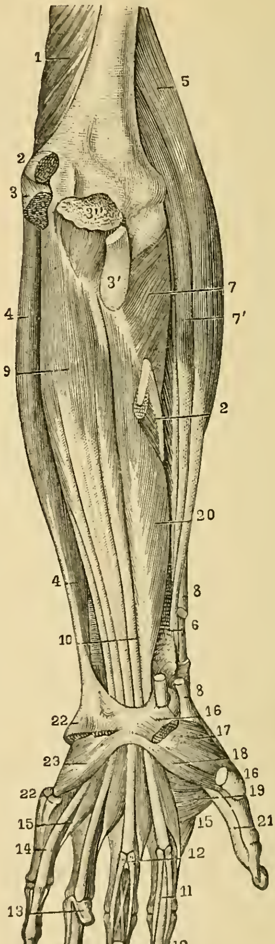
Flexor Profundus Digitorum. — This is the thickest muscle of the forearm. It *arises* from the upper two-thirds of the anterior surface of the ulna, surrounding the insertion of the brachial anticus above, from the same extent of its internal surface, from the aponeurosis attached to the posterior edge of the ulna, and from the ulnar two-thirds of the interosseous membrane (Fig 136). About the middle of the forearm the muscle is *inserted* into four flat tendons, of which only that which goes to the index finger is separate from the others above the wrist. These tendons lie upon the same plane, and pass beneath the annular ligament, under those of the superficial flexor, into the palm, where they diverge to pass to their respective fingers. On the first phalanx of the fingers the tendons of the deep flexor perforate those of the superficial, and are *inserted* into the bases of the third or ungual phalanges. It derives its *nerves* from the interosseous branch of the median and from the ulnar (Fig. 131, p. 337). Its *action* is to flex the third or ungual phalanges, the obliquity of its insertion giving rapidity and extent of motion, flexion continuing, the entire hand drawn upon the forearm.

Flexor Longus Pollicis. — This muscle is situated on the front surface of the radius, outside the preceding. It *arises* from the front surface of the radius, between the tubercle and the oblique ridge above, and the pronator quadratus below, and from the interosseous membrane.* Its tendon, which begins on the ulnar side of the muscle, proceeds beneath the annular ligament to the base of the last phalanx of the thumb. Its *nerve* comes from the interosseous branch of the median (Fig. 131, p. 337). Its *action* to flex the third or ungual phalanx of the thumb which from the bony formation allows a certain adduction to be accomplished at the same time.

Pronator Quadratus. — This square muscle *arises* from the lower fourth of the ulna and from a strong aponeurosis

* Sometimes by a slip from the coronoid process.

which covers its anterior surface; its fibres pass, some transversely, some obliquely outwards, and are *inserted* into the lower



1. Internal head of triceps.
2, 2. Origin of the pronator radii teres.
3. Attachment of superficial flexors.
3′ Tendon of the biceps.
3″ Tendon of the brachial anticus.
4, 4. Flexor carpi ulnaris.
5. Supinator longus or brachio-radialis.
6. Its insertion.
7 Supinator brevis.
7′. Extensor carpi radialis longior.
8, 8. Tendon of the extensor ossis metacarpi pollicis, excised to show the insertion of the supinator longus.
9. Flexor profundus digitorum.
10. Its four tendons.
11. Tendon to the index finger.
12, 12. Tendon to the middle finger, which has been partly excised to allow the groove to be seen and which holds the tendon of the flexor sublimis digitorum.
13. Tendon of the flexor sublimis digitorum of the ring finger, cut and turned down to show the groove on its posterior surface.
14. Tendon of the profundus digitorum to the little finger.
15, 15. Lumbricales.
16, 16. Attachment of the abductor pollicis.
17. Opponens pollicis.
18. Flexor brevis pollicis.
19. Adductor pollicis.
20. Flexor longus pollicis.
21. Tendon of this muscle.
22, 22. Attachments of the flexor brevis minimi digiti.
23. Opponens minimi digiti.

FIG. 136.—DEEP FLEXORS OF THE FINGERS AND THUMB.

fourth of the anterior surface and the outer border of the radius. It *pronates* the radius on the ulna. Its *nerve* proceeds from the interosseous branch of the median.

Anterior Interosseous Artery. — Nearly on a level with the insertion of the biceps the ulnar artery gives off from its outer side the *common interosseous*, which runs backwards for about an inch (*2.5 cm.*), and divides into the *anterior* and *posterior interosseous*.

The *anterior interosseous artery* runs down on the interosseous membrane, lying deeply between the flexor profundus digitorum and flexor longus pollicis. At the upper edge of the pronator quadratus it divides into two branches, one of which, the smaller, passes beneath the muscle, supplies it and the front of the carpal bones, communicating with the anterior carpal arteries from the radial and ulnar; the other, the more important, perforates the interosseous membrane and helps to supply the muscles on the back of the forearm.

A branch, the *arteria comes nervi mediani*, proceeds from the anterior interosseous. It lies in close contact with the nerve, sometimes in its very centre; though usually of small size, it may be as large as the ulnar artery itself, and, in such cases, it passes under the annular ligament with the nerve to join the palmar arch. This is interesting, because it helps to explain the recurrence of hemorrhage from a wound in the palm, even after the radial and ulnar arteries have been tied.

The anterior interosseous artery gives off branches to the muscles on each side; also the *nutrient arteries* which enter the radius and ulna, near the centre of the forearm, to supply the medullary membrane; these arteries pass upwards towards the elbow.

Anterior Interosseous Nerve. — This nerve is a branch of the median; it generally runs close to the radial side of the artery, and supplies the flexor longus pollicis, half the flexor profundus digitorum, and the pronator quadratus (Fig. 131, p. 337).

DISSECTION OF THE PALM OF THE HAND.

Surface Marking. — On the ulnar side of the palm of the hand is a round, long eminence, *hypothenar*, which corresponds with the muscles of the ball of the little finger; and on the radial side, placed obliquely over the metacarpal bone of the thumb, is another eminence, *thenar*, which is caused by the muscles of the ball of the thumb. Between the two eminences, at the wrist, is a slight depression, corresponding with the middle of the annular ligament, and which broadens out towards the fingers. The palm of the hand, about an inch (*2.5 cm.*) from the clefts of the fingers, presents a transverse furrow, which corresponds with the metacarpo-phalangeal articulations, with the distal limit of the synovial sheaths of the flexor tendons, with the divisions of the palmar fascia into its four processes, and with the transverse metacarpal ligament. The superficial palmar arch may be indicated by a line drawn from the cleft of

the extended thumb across the palm; the deep palmar arch lies half an inch (*13 mm.*) nearer the annular ligament.

Dissection. — Make a vertical incision along the centre of the palm, and a transverse one along the bases of the finger; from this transverse cut continue vertical incisions along the front of the fingers, and reflect the skin; taking care not to remove a small cutaneous muscle — the palmaris brevis — situated over the ball of the little finger, and also two small cutaneous branches of the median and ulnar nerves, which are found in the fat of the palm.

Observe how closely, in the centre of the palm, the skin adheres to the palmar fascia beneath it. On the ball of the little finger and the distal ends of the metacarpal bones the subcutaneous structure is composed of a dense filamentous tissue, which contains numerous pellets of fat, forming an elastic pad. A similar padding protects the palmar surfaces of the fingers. These cushions on the ends of the fingers defend them in the powerful actions of the hand; they are also useful in subservience to the nerves of touch.

The palm is supplied with nerves by three small branches — the *palmar branch* of the median passes in front of the anterior annular ligament to the centre of the palm; the *palmar branch* of the ulnar supplies the inner aspect of the hand; and the *anterior branch* of the musculo-cutaneous nerve is distributed to the skin over the thenar eminence. The terminal branches of these cutaneous nerves communicate with each other.

Palmaris Brevis. — This small cutaneous muscle is situated on the inner side of the palm. It *arises* from the inner edge of the central palmar fascia, and the annular ligament, and is *inserted* into the skin on the ulnar border of the palm. Its *use* is to support the pad on the inner edge of the palm; it acts powerfully as we grasp; it raises the inner edge of the palm, and deepens the hollow of it, forming the so-called "cup of Diogenes." It is supplied by the ulnar *nerve*.

Palmar Fascia. — This fascia has a silvery lustre, and in the centre of the palm is remarkably dense and strong. It is divided into three portions: a *central*, by far the strongest; an *external*, covering the muscles of the thumb; and an *internal*, covering the muscles of the little finger. From the deep surface of the fascia two septa dip down and divide the palm into three separate compartments; one for the ball of the thumb, a second for that of the little finger, and a third for the centre of the palm.

The fascia is formed by a prolongation from the anterior annular ligament. It is also strengthened by the expanded tendon of the palmaris longus.

The central portion of the fascia is triangular, with the apex at the wrist. About the middle of the palm it splits into four portions, which are connected by transverse tendinous fibres, extending completely across the palm and corresponding pretty nearly to the transverse furrow of skin in this situation.

Examine any one of these four portions of the fascia, and you will find that it splits into two strips which embrace the corresponding flexor tendons, and are intimately connected with the transverse metacarpal ligament. The effect of this is that the flexor tendons of each finger are kept in place in the palm by a fibrous ring. Between the four divisions of the palmar fascia the digital vessels and nerves emerge, and descend in a line with the clefts between the fingers.

In the hands of mechanics, in whom the palmar fascia is usually very strong, we find that slips of it are lost in the skin at the lower part of the palm, and also for a short distance along the sides of the fingers.

The chief use of the palmar fascia is to protect the vessels and nerves from pressure when anything is grasped in the hand. It also confines the flexor tendons in their proper place.

Beneath the interdigital folds of the skin there are aponeurotic fibres to strengthen them, constituting what are called the *transverse ligaments* of the fingers. They form a continuous ligament across the lower part of the palm, in front of the digital vessels and nerves.

Dissection. — Cut through the palmar fascia at its attachment to the anterior annular ligament, and reflect it towards the fingers, so as to expose the vessels, nerves, and tendons in the palm. The vessels lie above the nerves, and the tendons still deeper. There is an abundance of loose connective tissue to allow the free play of the tendons. When suppuration takes place in the palm it is seated in this tissue. Reflect for a moment what mischief is likely to ensue. The pus cannot come to the surface through the dense palmar fascia or on the back of the hand; it will, therefore, run up into the carpal bursa under the annular ligament, and make its way deep amongst the tendons of the forearm.

Superficial Palmar Arch. — The ulnar artery, having passed over the annular ligament, near the pisiform bone, describes a

curve across the upper part of the palm, beneath the palmar fascia, towards the thumb, and, gradually diminishing in size, inosculates with the superficialis volæ, and very commonly with a branch from the arteria radialis indicis, to form the *superficial palmar arch.* The curve of the arch is directed towards the fingers, its greatest convexity descending as low as a horizontal

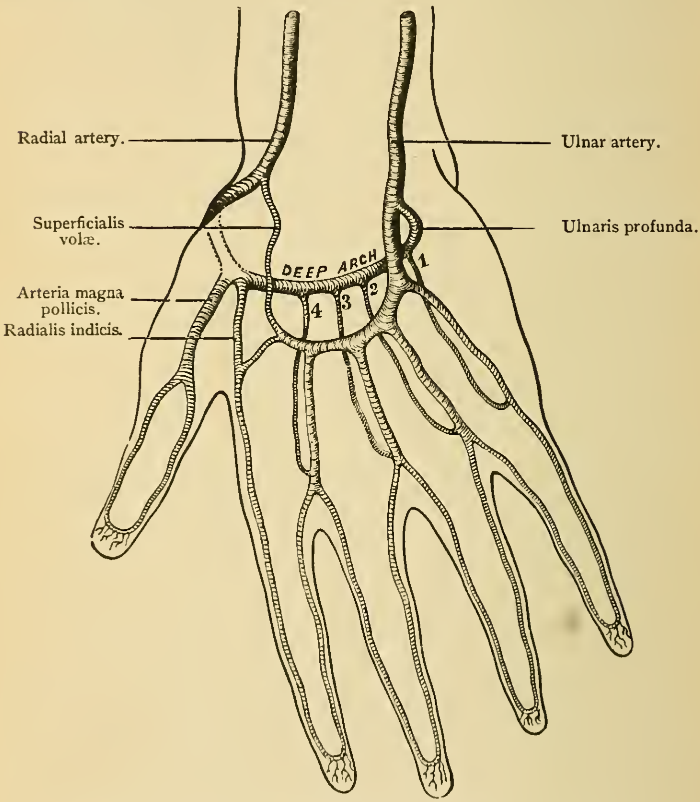


FIG. 137.—DIAGRAM OF THE SUPERFICIAL AND DEEP PALMAR ARCHES.
1, 2, 3, 4. Interosseous branches.

line drawn across the junction of the upper with the middle third of the palm.

In its passage over the annular ligament the artery lies in the furrow, between the pisiform and unciform bones, and is protected by an expansion from the tendon of the flexor carpi ulnaris to the palmaris longus. The ulnar nerve lies close to

the inner side of the artery, both being covered by the palmaris brevis. In the palm the artery rests for a short distance upon the muscles of the little finger, then it lies upon the superficial flexor tendons and the divisions of the ulnar and median nerves, and is covered by the palmar fascia.

Immediately below the pisiform bone the ulnar artery gives off the *ulnaris profunda*, which sinks deeply into the palm, between the origins of the abductor and flexor brevis minimi digiti, to form the deep palmar arch, by joining the terminal branch of the radial artery. It is accompanied by the deep branch of the ulnar nerve.

From the concavity of the arch small *recurrent branches* ascend to the carpus, and inosculate with the other carpal branches of the radial and ulnar arteries.

Four digital arteries arise from the convexity of the superficial palmar arch. They supply all the digits, except the thumb and the radial side of the index finger. The *first* descends over the muscles on the inner side of the palm, to the ulnar side of the little finger, along which it runs to the apex. The *second*, *third*, and *fourth* descend nearly vertically between the tendons, *in a line with the clefts* between the fingers, and, about half an inch (*13 mm.*) above the clefts, each divides into two branches, which proceed along the opposite sides of the fingers nearly to the end of the last phalanges, where they unite to form an arch with the convexity towards the end of the finger; from this arch numerous branches supply the papillæ at the tip of the finger.

In the palm of the hand the digital arteries, before they divide, are joined by branches from the corresponding palmar interosseous arteries (branches of the deep palmar arch) (Fig. 137, p. 358).

The digital arteries freely communicate, on the palmar and dorsal aspect of the fingers, by transverse branches, which supply the joints and the sheaths of the tendons. Near the ungual phalanx, a considerable branch passes to the back of the finger, and forms a network of vessels which supply the matrix of the nail.

Ulnar Nerve in the Palm. — The *ulnar nerve* passes over the annular ligament into the palm, on the inner side of the ulnar artery, and a little behind it. It lies in the groove between the pisiform and unciform bones, so that it is perfectly secure from pressure. Immediately below the pisiform bone, the nerve divides into a superficial and a deep palmar branch. The *deep* branch supplies the muscles forming the ball of the little finger, and accompanies the ulnaris profunda artery into the palm, to supply *all* the interosseous muscles, the two ulnar lumbricales, and it ends in branches which are distributed to the first dorsal interosseous, the adductor pollicis, and the inner

head of the flexor brevis pollicis; it, moreover, sends filaments which ascend to supply the wrist-joint, and others which descend to the metacarpo-phalangeal joints. The *superficial* branch sends filaments to the palmaris brevis, to the skin on the inner side of the palm, and then divides into two digital nerves, one for the supply of the ulnar side of the little finger, the other for the contiguous sides of the little and ring fingers.* This branch also communicates with the median nerve behind the superficial palmar arch. All the digital branches run along the sides of the fingers to their extremities superficial to their corresponding arteries (Fig. 131, p. 337).

Anterior Annular Ligament of the Carpus.† — This exceedingly strong and thick ligament confines the flexor tendons of the fingers and thumb, and fastens together the bones of the carpus. It is attached, externally, to the tuberosity of the scaphoid and the ridge on the trapezium; internally, to the pisiform and unciform. Its upper border is continuous with the aponeurosis in front of the wrist; its lower is connected with the palmar fascia; its anterior surface receives the expanded tendon of the palmaris longus, and gives origin to most of the muscles of the ball of the thumb and little finger (Fig. 133, p. 344).

Now proceed to the muscles composing the ball of the thumb and the little finger. The dissection of them requires considerable care.

Muscles of the Ball of the Thumb or Thenar Eminence. — The great strength of the muscles of the ball of the thumb is one of the distinguishing features of the human hand. This strength is necessary in order to oppose that of all the fingers. In addition to its strength, the thumb enjoys perfect mobility. It has no less than eight muscles — namely, an abductor, an opponens, two flexors, three extensors, and an adductor.

Abductor Pollicis. — This is the most superficial (Fig. 133, No. 24, p. 344). It is a thin, flat muscle, and *arises* from the ridge of the os trapezium and the annular ligament. It passes forwards and outwards, and is *inserted* by a flat tendon into the radial side of the base of the first phalanx and the extensor

* Occasionally a branch may be found supplying the ulnar side of the middle finger. — A. H.

† Should be called the *ventral annular fascia* or *ventral volar ligament*, and according to Dr. J. Francis Walsh's Boylston Prize Essay, 1897, the sheath of the tendon of the flexor carpi radialis is attached to it. — A. H.

aponeurosis of the thumb. Its *action* is to abduct and flex the first phalanx of the thumb. Its *nerve* comes from the median. Reflect it from its insertion to expose the following: —

Opponens Pollicis. — This muscle *arises* from the front of the os trapezium (Fig. 136, No. 17, p. 354) beneath the abductor, and from the annular ligament, and, passing forwards and outwards, is *inserted*, more or less obliquely, into the whole length of the radial side of the metacarpal bone of the thumb. The *action* of this powerful muscle is to rotate the metacarpal bone on its vertical axis, and then draw the whole thumb inwards, thus opposing the thumb to all the fingers. Its *nerve* comes from the median. Reflect it from its insertion, to expose the following: —

Flexor Brevis Pollicis. — This muscle has *two origins*, between which runs the tendon of the flexor longus pollicis: *one*, the superficial, from the annular ligament and trapezium; the *other*, the deep, from the trapezium, trapezoid, os magnum, the bases of the second and third metacarpal bones, and the sheath of the tendon of the flexor carpi radialis. It is *inserted* by two strong tendons into the base of the first phalanx of the thumb on the inner and outer sides; the superficial tendon being connected with the abductor pollicis, and the deep one with the adductor pollicis. A sesamoid bone is found in each of the tendons. The tendons of insertion of this muscle are separated by the long flexor tendon of the thumb and the arteria magna pollicis. Its *action* is to bend the first phalanx of the thumb. The individual bellies acting to assist in abduction and adduction. The superficial portion is supplied by the median nerve; the deep, by the ulnar (Fig. 136, No. 18, p. 354).

Adductor Pollicis. — This triangular muscle *arises* from the palmar aspect of the shaft of the metacarpal bone of the middle finger; its fibres converge and are *inserted*, along with the deep or inner portion of the flexor brevis pollicis, into the base of the first phalanx of the thumb and the internal sesamoid bone. Its *action* is to draw the thumb towards the palm, as when we bring the tips of the thumb and little finger into contact. It is supplied by the deep branch of the ulnar nerve, which also supplies the deep head of the flexor brevis pollicis. The other muscles of the ball of the thumb are supplied by the median nerve (Fig. 136, No. 19, p. 354).

Muscles of the Ball of the Little Finger or Hypothenar Eminence. — The muscles of the little finger correspond in

some measure with those of the thumb. Thus there is an abductor, a flexor brevis, and an opponens minimi digiti. All derive their *nerves* from the deep branch of the ulnar.

Abductor Minimi Digiti. — This, the most superficial of the muscles of the little finger, *arises* (Fig. 134, No. 23, p.346) from the pisiform bone, and from the tendinous expansion of the flexor carpi ulnaris; it is *inserted* by a flat tendon into the inner side of the base of the first phalanx of the little finger, and is prolonged according to Walsh* as an interphalangeal muscle to be lost in the tendon common to it and the common extensor tendon, and is *inserted* into the bases of the second and third phalanges, posteriorly. Its *action* is to extend the third on the second and the second on the first phalanges, and then abduct the whole finger. It may flex the phalanges and then abduct. Its *nerve* comes from the deep branch of the ulnar.

Flexor Brevis Minimi Digiti. — It *arises* from the apex of the unciform bone and annular ligament, and is *inserted* with the tendon of the abductor into the base of the first phalanx and to the flexor sheath of the little finger. Its *action* is similar to that of the abductor. *Nerve* from deep branch of ulnar. Between the origins of the abductor and flexor brevis minimi digiti, the deep branch of the ulnar artery and nerve sinks down to form the deep palmar arch (Fig. 134, No. 24, p. 346).

Opponens Minimi Digiti. — The last two muscles must be reflected from their insertion, to expose the *opponens minimi digiti*. It *arises* from the unciform process and the annular ligament, and is *inserted* along the ulnar side of the shaft of the metacarpal bone of the little finger. Its *action* is to flex the little finger, and rotates on its long axis, thus assisting to produce the cupping or depression of the palm. Thus it greatly strengthens the grasp of the palm. *Nerve* from deep branch of ulnar (Fig. 136, No. 23, p. 354).

Dissection. — Cut vertically through the anterior annular ligament, and observe that, with the carpal bones, it forms an elliptical canal, with the broad diameter transversely. This canal is lined by a synovial membrane which is reflected loosely over the tendons. Superficial to the ligament pass the palmaris longus, the ulnar artery and nerve, the fibrous expansion from the flexor carpi ulnaris covering these vessels and nerve, and the palmar branch of the median and ulnar nerves; beneath it pass the superficial and deep flexor tendons of the fingers, the

* Boylston Prize Essay. Dr. J. Francis Walsh, 1897.

long flexor tendon of the thumb, and the median nerve. The tendon of the flexor carpi radialis does not run with the other tendons, but is contained in a distinct sheath, lined by a separate synovial membrane, formed, partly by the annular ligament, and partly by the groove in the trapezium.

Median Nerve in the Palm. — In its passage under the annular ligament, the median nerve is enveloped in a fold of synovial membrane, and lies upon the flexor tendons. Here it becomes enlarged and flattened, and of a pinkish color, and divides into two nearly equal parts : the *external* gives a recurrent branch to the muscles of the ball of the thumb — namely, to the abductor pollicis, the opponens pollicis, and the outer head of the flexor brevis pollicis, and then terminates in three digital nerves, two of which are distributed to the thumb, and the third to the radial side of the index finger ; the *internal* gives digital branches which supply the ulnar side of the index, both sides of the middle finger, and the radial side of the ring finger (Fig. 131, p. 337).

The *two* nerves to the thumb proceed, one on each side of the long flexor tendon, to the last phalanx: the outer one being connected with a terminal filament of the radial.

The *third* digital nerve runs along the radial side of the index finger. The *fourth* descends towards the cleft between the index and middle fingers, and subdivides into two branches, which supply their opposite sides. The *fifth* is joined by a filament from one of the ulnar digital nerves, and then subdivides above the cleft between the middle and ring fingers, to supply their opposite sides.

Two small branches are given off from the third and fourth digital nerves to supply the two radial lumbricales, the two ulnar being supplied by the ulnar nerve.

About an inch and a quarter (*3.1 cm.*) above the clefts between the fingers, each digital nerve subdivides into two branches, between which the digital artery passes and bifurcates lower down ; therefore a vertical incision down the cleft would divide the artery before the nerve.

In their course along the fingers and thumb, the nerves lie superficial to the arteries, and nearer to the flexor tendons. About the base of the first phalanx each nerve sends a *dorsal branch*, which runs along the back of the finger nearly to the extremity, communicating with the dorsal branches derived from the radial and ulnar nerves. Near the ungual phalanx another dorsal or ungual branch is distributed to the skin around and beneath the matrix of the nail. Each digital nerve terminates in the cushion at the end of the finger in a brush of filaments, with their points directed into the papillæ of the skin.

Flexor Tendons and their Sheaths. — Immediately below the annular ligament the tendons separate from each other :

near the metacarpal joints they pass in pairs, through strong fibrous rings (p. 356) formed by the divisions of the palmar fascia. Below the metacarpal joint the two tendons for each finger enter the sheath, *theca*, which confines them in their course along the phalanges. It is formed by a strong fibrous membrane, which is attached to the ridges on the phalanges, and converts the groove in front of these bones into a complete canal, exactly large enough to contain the tendons. The density of the sheath varies in particular situations, otherwise there would be an obstacle to the easy flexion of the fingers. To ascertain this, cut open one of the sheaths along its entire length; you will then see that it is much stronger between the joints than over the joints themselves. Through these sheaths inflammation, commencing in the integuments of the finger, may readily extend to the synovial membrane of the tendon.

In cases of whitlow, when pus forms in the theca, the incision should be made deep enough to lay open this fibro-osseous canal, without which the incision will be of no use. It is obvious that the incision should be made down the *centre* of the finger, to avoid the digital nerves and arteries. If this opening be not timely made, the flexor tendons are likely to slough, and the finger becomes stiff.*

But what protects the joints of the fingers where the flexor tendons play over them? Look into an open sheath and you will see that in front of the joints the tendons glide over a smooth fibro-cartilaginous structure caled the *palmar* ligament.

To facilitate the play of the tendons the interior of the sheath, as well as the tendons, is lined by a synovial membrane, of the extent of which it is important to have a correct knowledge. With a probe you may ascertain that the synovial membrane is reflected from the sheath upon the tendons, a little above the metacarpal joints of the fingers — that is, nearly in a line with the transverse fold in the skin in the lower third of the palm. Towards the distal end of the finger the synovial sheath stops

* On closer inspection it will be observed that the sheath is composed of bands of fibres, which take different directions, and have received distinct names. The strongest are called the *ligamenta vaginalia.* They constitute the sheath over the body of the phalanx, and extend transversely from one side of the bone to the other. The *ligamenta cruciata* are two slips, which cross obliquely over the tendons. The *ligamenta annularia* are situated immediately in front of the joints, and may be considered as thin continuations of the ligamenta vaginalia. They consist of fibres, which are attached on either side to the lateral ligaments of the joints, and pass transversely over the tendons.

short of the last joint, so that it is not injured in amputation of the ungual phalanx.

And now notice how the tendons are adapted to each other in their course along the finger. The superficial flexor, near the root of the finger, becomes slightly grooved to receive the deep flexor; about the middle of the first phalanx it splits into two portions, through which the deep flexor passes. The two portions reunite below the deep tendon so as to embrace it, and then divide a second time into two slips, which interlace with each other, and are inserted into the sides of the second phalanx. The *deep* flexor, having passed through the opening of the superficial one, is inserted into the base of the last phalanx (Fig. 136, Nos. 12, 13, p. 354).

In what way are the tendons supplied with blood? Raise and separate the tendons, and you will see that slender but very vascular folds of synovial membrane (*vincula tendinum*) run up from the phalanges and convey blood-vessels to the tendons.

The *tendon of the flexor longus pollicis* lies on the radial side of the other tendons beneath the annular ligament. It passes between the two portions of the flexor brevis pollicis and the two sesamoid bones of the thumb, enters its proper sheath, and is *inserted* into the base of the last phalanx. Its synovial sheath is prolonged from the large bursa of the flexor tendons beneath the annular ligament, and accompanies the tendon down to the last joint of the thumb; consequently the sheath is injured in amputation of the last phalanx.

Bursal Sac of the Carpus. — A large and loose synovial sac (bursa of the carpus) facilitates the play of the tendons beneath the anterior annular ligament. It lines the under surface of the ligament and the groove of the carpus, and is reflected in loose folds over the tendons. It is prolonged up the tendons for an inch and a half or two inches (*3.8 to 5 cm.*), and forms a cul-de-sac above the ligament. Below the ligament the bursa extends into the palm, and sends off prolongations for each of the flexor tendons, which accompany them down to the middle of the hand. You will understand that when the bursa is inflamed and distended by fluid, there will be a bulging above the annular ligament and another in the palm, with perceptible fluctuation between them, the unyielding ligament causing a constriction in the centre.

Lumbricales. — These four slender muscles, one for each finger, are attached to the deep flexor tendons in the palm.

All of them *arise* by fleshy fibres from the radial side and palmar surface of the deep tendon of their corresponding finger; the third and fourth also arise from the adjacent sides of two tendons. Each terminates in a broad, thin tendon, which passes over the radial side of the first joint of the finger and is *inserted*, by a broad expanded aponeurosis, into the extensor tendon on the dorsal aspect of the first phalanx of the finger. Their *action* is to flex the first phalanx and to extend the second and third phalanges. Being inserted near the centre of motion, they can move the fingers with great rapidity. As they produce the quick motions of the musician's fingers, they were called by the old anatomists *fidicinales* (Fig. 136, No. 15, p. 354).

The two ulnar lumbricales are supplied by the deep branch of the ulnar nerve; the two radial by the third and fourth digital branches of the median nerve.

Dissection. — Now cut through all the flexor tendons, and remove the deep fascia of the palm, to see the deep arch of arteries and its branches.*

Branches of the Radial Artery in the Palm. — The radial artery, sinking into the space between the first and second metacarpal bones, and between the two heads of the abductor indicis, enters the palm between the inner head of the flexor brevis and the adductor pollicis, and gives off three branches — the arteria princeps pollicis, the radialis indicis, and the palmaris profunda, which unites with the deep ulnar artery to form the deep arch.

The *arteria princeps pollicis* runs behind the deep head of the flexor brevis pollicis and in front of the abductor indicis (first dorsal interosseous), close along the metacarpal bone of the thumb; in the interval between the lower portions of the flexor brevis pollicis, the artery divides into two digital branches, which proceed one on either side of the thumb, and inosculate at the apex of the last phalanx. Their distribution and mode of termination are like those of the other digital arteries.

The *arteria radialis indicis* runs between the abductor indicis and adductor pollicis, along the radial side of the index finger to the end, where it forms an arch with the other digital artery, a branch of the ulnar. Near the lower margin of the abductor pollicis, the radialis indicis generally receives a branch from the princeps pollicis, and gives a branch to the superficial palmar arch.

The *palmaris profunda* may be considered as the continuation of the radial artery. It enters the palm between the inner head of the flexor brevis and the adductor pollicis, and, running

* The course and relations of the radial artery as it winds round the wrist will be described in the dissection of the back of the hand.

upon the bases of the metacarpal bones, inosculates with the deep branch of the ulnar artery, thus completing the *deep palmar arch.* From the concavity of the arch small recurrent branches ascend to supply the bones and joints of the carpus, inosculating with the other carpal arteries.

From the convexity of the arch three or four small branches, called *palmar interosseous* (Fig. 137, p. 358), descend to supply the interosseous muscles, and near the clefts of the fingers communicate with the digital arteries. These palmar interosseous branches are sometimes of considerable size, and take the place of one or more of the digital arteries, ordinarily derived from the superficial palmar arch. Three branches, called *perforating*, pass between the upper ends of the metacarpal bones to the back of the hand, and communicate with the carpal branches of the radial and ulnar.

Deep Branch of the Ulnar Nerve. — This nerve sinks into the palm with the ulnaris profunda artery, between the abductor and flexor brevis minimi digiti. It then runs with the deep palmar arch towards the radial side of the palm, and terminates in the adductor pollicis, in the inner or deep head of the flexor brevis pollicis, and in the first dorsal interosseous. Between the pisiform and unciform bones, the nerve gives a branch to each of the muscles of the little finger. Subsequently it sends branches to each interosseous muscle and to the two inner lumbricales (Fig. 131, No. 32, p. 337).

The tendon of the flexor carpi radialis in the palm must now be followed to its insertion into the base of the second metacarpal bone.

The dissection of the remaining muscles of the palm called, from their position, *interossei*, must be, for the present, postponed.

MUSCLES OF THE BACK CONNECTED WITH THE ARM.

Dissection. — Make an incision down the middle of the spine from the occiput to the sacrum ; another, from the last thoracic vertebra upwards and outwards to the acromion ; and a third from the sacrum along the crest of the ilium ; then reflect the skin outwards from the dense subcutaneous tissue, in which will be found the following cutaneous nerves : —

Cutaneous Nerves of the Back. — These are derived from the posterior divisions of the spinal nerves, and correspond, generally, to the number of the vertebræ. The posterior primary branches, much smaller than the anterior, divide, between the transverse processes, into *external* and *internal* branches, with the exception of the suboccipital, the fourth and fifth sacral, and the coccygeal nerves.

Posterior Branches of the Cervical Nerves. — The *posterior primary branches of the cervical nerves* (except the first*) divide into external and internal branches: the *external* are distributed solely to some of the muscles of the neck, and which will be dissected later on; the *internal*, larger than the external, are distributed in the following manner: the *second*, or the *great occipital nerve*, perforates the complexus and ramifies on the back of the scalp with the occipital artery; the *third*, *fourth*, and *fifth* nerves, after sending branches to the multifidus spinæ, semi-spinalis, and the complexus, emerge through the trapezius close to the spinous processes, and then pass transversely across that muscle to supply the skin over it; the branch of the *third cervical nerve* sometimes sends a branch to the back of the scalp;† the branches of the *sixth*, *seventh*, and *eighth* are small, and are situated beneath the semispinalis, to which they are distributed.

Posterior Branches of the Thoracic Nerves. — The *external branches* become superficial between the longissimus dorsi and the ilio-costalis, and supply these muscles and the other divisions of the erector spinæ; the six lower supply cutaneous nerves in the line of the angles of the ribs. The *internal branches*, as to the upper six thoracic, emerge between the multifidus spinæ and semispinalis, and, passing horizontally outwards, end in branches to the skin close to the spinous processes; that from the second ramifies over the spine of the scapula; the six lower do not become cutaneous, but terminate in the multifidus spinæ.

Posterior Branches of the Lumbar Nerves. — The *external branches* from the first, second, and third lumbar nerves perforate the ilio-costalis and the latissimus dorsi, and then descend over the crest of the ilium, supplying cutaneous branches to the gluteal region; the fourth supplies the erector spinæ without becoming cutaneous; the fifth sends down a branch to communicate with the first sacral nerve. The *internal branches* are small, and end in the multifidus spinæ.

Posterior Branches of the Sacral Nerves. — The *external branches* of the upper three sacral nerves form a series of loops with themselves, and also with the last lumbar above and the fourth sacral below; they pass to the superficial surface of the great sacro-sciatic ligament, where they form another series of loops, from which filaments are distributed to the skin after piercing the gluteus maximus. The *internal branches* of the three upper sacral nerves are distributed to the multifidus spinæ. The posterior branches of the fourth and fifth sacral nerves do not divide into external and internal branches, but form a loop, the lower one being joined with the coccygeal nerve.

Coccygeal Nerve. — The posterior division of this nerve, after being joined by a branch from the last sacral, is distributed to the posterior aspect of the coccyx.

Dissection. — The trapezius and latissimus dorsi, which form the first layer of muscles, must now be cleaned by putting them on the stretch and reflecting the connective tissue which covers them; they should then be dissected in the course of their fibres.

Trapezius. — Alone, this muscle is triangular; with its fellow, it presents a trapezoid form. It *arises* from the inner fourth, more or less, of the superior curved line of the occiput,

* This nerve has already been described in the dissection of the suboccipital triangle (p. 292).

† The internal branches of the first, second, and third cervical nerves form a communication beneath the complexus, which is called by Cruveilhier the *posterior cervical plexus*.

a, *a*, Small occipital nerve from the cervical plexus; 1, external muscular branches of the first cervical nerve and union by a loop with the second; 2, the rectus capitis posticus major, with the great occipital nerve passing round the short muscles and piercing the complexus; the external branch is seen to the outside; 2′, the great occipital; 3, external branch of the posterior primary division of the third nerve; 3′, its internal branch, or third occipital nerve; 4′, 5′, 6′, 7′, 8′, internal branches of the several corresponding nerves on the left side; the external branches of these nerves proceeding to muscles are displayed on the right side: *d* 1 to *d* 6, and thence to *d* 12, external muscular branches of the posterior primary divisions of the twelve thoracic nerves on the right side; *d* 1′, to *d* 6′, the internal cutaneous branches of the six upper thoracic nerves on the left side; *d* 7′ to *d* 12′, cutaneous branches of the six lower thoracic nerves from the external branches; *l*, *l*, external branches of the posterior primary branches of several lumbar nerves on the right side piercing the muscles, the lower descending over the gluteal region; *l*′, *l*′, the same more superficially on the left side; *s*, *s*, on the right side, the issue and union by loops of the posterior primary divisions of four sacral nerves, *s*′, *s*′, some of these distributed to the skin on the left side.

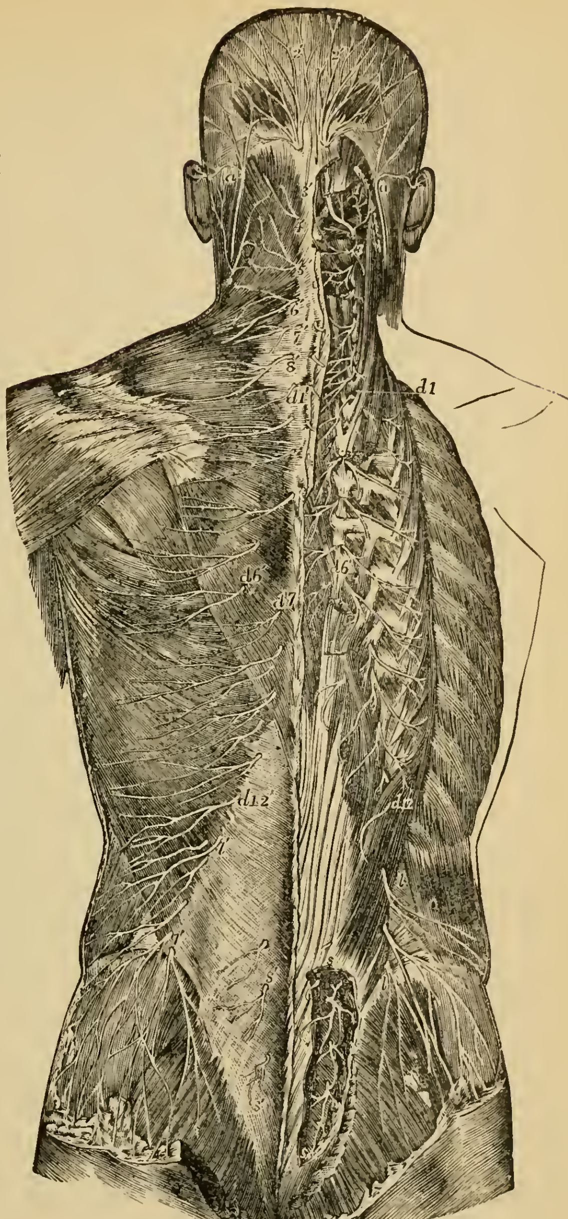


FIG. 138.—DIAGRAM OF THE CUTANEOUS NERVES OF THE BACK.

from the ligamentum nuchæ,* from the spinous processes of the seventh cervical, and all the thoracic vertebræ, and from their supraspinous ligament. The fibres converge towards the shoulder. The upper pass downwards and outwards, and are *inserted* by fleshy fibres into the external third of the clavicle; the middle pass transversely outwards into the inner border of the acromion and the superior lip of the spine of the scapula; the lower pass upwards and outwards, and terminate in a thin tendon, which plays over the triangular surface at the back of the scapula, and is *inserted* into the beginning of the spine. The insertion of the trapezius exactly corresponds to the origin of the deltoid, and the two muscles are connected by a thin aponeurosis over the spine and acromion. If both the trapezius muscles be exposed, observe that, between the sixth cervical and the third thoracic vertebræ, their origin presents an aponeurotic space of an elliptical form (Fig. 139, p. 371).

The structures covered by the trapezius are: the splenius, the complexus, the levator anguli scapulæ, the rhomboidei minor and major, the supraspinatus, a small part of the infraspinatus, the serratus posticus superior, the vertebral aponeurosis, the latissimus dorsi, the ilio-costalis, the spinal accessory nerve, and the superficialis colli artery.

The fixed point of the muscle being at the vertebral column, all its fibres tend to raise the shoulder. The deltoid cannot raise the humerus beyond an angle of ninety degrees: beyond this, the elevation of the arm is principally effected by the rotatory movement of the scapula. The trapezius is in strong action when a weight is borne upon the shoulders; again, its middle and inferior fibres act powerfully in drawing the scapula backwards, as in preparing to strike a blow. If both muscles act, they draw the head backwards; if one only acts, it draws the head to the same side. It is *supplied* by the nervus accessorius and the deep branches of the cervical plexus, and by the superficialis colli artery.

Latissimus Dorsi.† — This broad flat muscle occupies the

* The ligamentum nuchæ is, in man, only a rudiment of the great elastic ligament which supports the weight of the head in quadrupeds. It extends from the spine of the occiput to the spines of all the cervical vertebræ, except the atlas; otherwise it would impede the free rotation of the head. In the giraffe this ligament is six feet long and as thick as a man's forearm. Professor Quekett states that when divided it shrinks at least two feet.

† This muscle is classified by Morris as forming the second layer with the levator anguli scapuli, the rhomboidei. (A. H.)

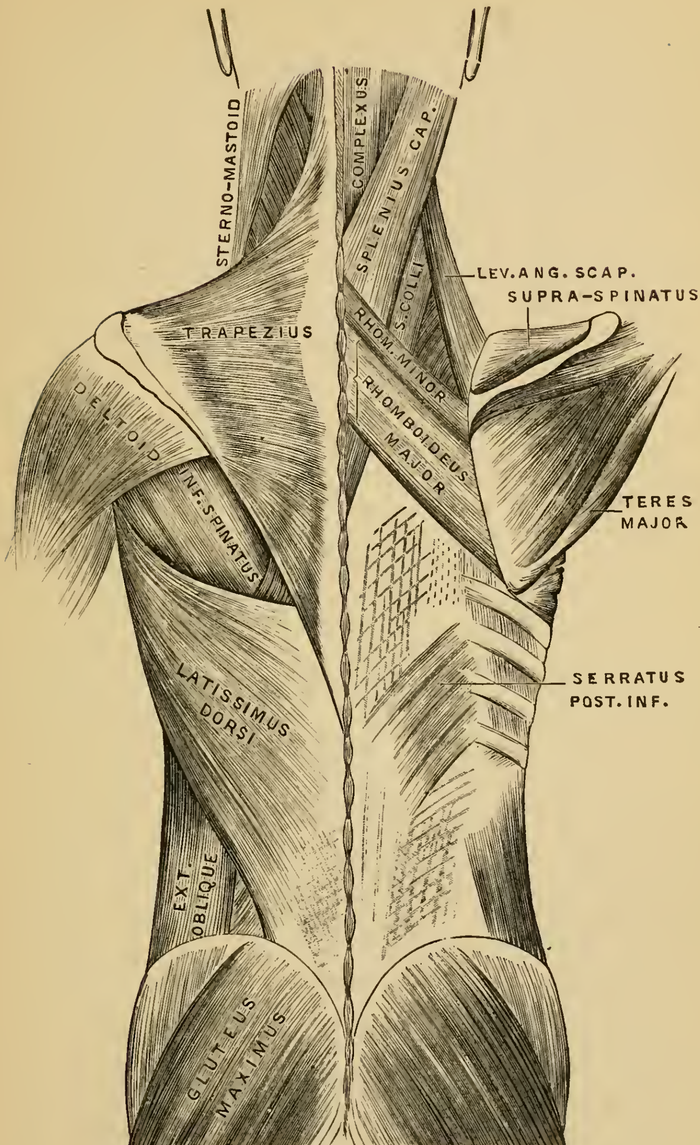


FIG. 139.—THE SUPERFICIAL MUSCLES OF THE BACK.

lumbar and lower thoracic regions, and thence extends to the arm, where it forms part of the posterior boundary of the axilla. It *arises* from the posterior third of the external lip of the crest of the ilium, from the spinous processes of the two upper sacral, all the lumbar and the six lower thoracic vertebræ, and their supraspinous ligament, by a strong aponeurosis; and, lastly, from the three or four lower ribs by fleshy slips, which interdigitate with those of the external oblique muscle of the abdomen. All the fibres converge towards the axilla, where they form a thick muscle, which curves over the inferior angle of the scapula, and is *inserted* by a broad, flat tendon into the bottom of the bicipital groove of the humerus. The upper fibres are inserted into the lowest of the groove, the lower fibres into the upper part. The tendon is about two inches (*5 cm.*) broad, and lies in front of and higher than that of the pectoralis major and of the teres major, from which it is separated by a large *bursa*.* It is *supplied* mainly by the long subscapular nerve, also by the posterior branches of the thoracic and lumbar nerves.

The latissimus dorsi draws the humerus inwards, downwards, and backwards, rotating it also inwards. It co-operates with the pectoralis major in pulling any object towards the body; if the humerus be the fixed point, it raises the body, as in climbing. The object of the muscle arising so high up the back is, that the transverse fibres of the muscle may strap down the inferior angle of the scapula. It sometimes happens that the scapula slips above the muscle; this displacement is readily recognized by the unnatural projection of the lower angle of the bone, and the impaired movements of the arm.†

The muscle covering the latissimus dorsi is the trapezius above; those lying beneath it are, a small part of the rhomboideus major, of the infraspinatus, and of the teres major, the serratus posticus inferior, the spinalis dorsi, the longissimus dorsi, the ilio-costalis, and the external intercostals. Between the base of the scapula, the trapezius, and the upper border of the latissimus dorsi, a triangular space is observed when the

* The latissimus dorsi frequently receives a distinct accessory slip from the inferior angle of the scapula.

† We have seen several instances of this displacement. There is great projection of the inferior angle of the scapula, especially when the patient attempts to raise the arm. He cannot raise the arm beyond a right angle, unless firm pressure is made on the lower angle of the scapula, so as to supply the place of the muscular strap. Whether the scapula can be replaced or not, a firm bandage should be applied round the chest.

arm is raised, in which the lower fibres of the rhomboideus major and part of the sixth intercostal space are exposed. Immediately above the crest of the ilium, between the free margins of the latissimus dorsi and external oblique, there is, also, an interval in which a little of the internal oblique can be seen.

The triangle formed by the outer border of the latissimus dorsi, the posterior border of the external oblique, and the crest of the ilium between them, is termed *Petit's triangle*, and may be the seat of hernia. (A. H.)

Lumbar or Vertebral Aponeurosis. — This dense shining aponeurosis of the back (sometimes termed the aponeurosis of the latissimus dorsi) forms the posterior part of the sheath of the erector spinæ. It is pointed above, where it is continuous with the deep cervical fascia, broader and stronger below. It consists of tendinous fibres, which are attached internally to the spines of the thoracic, all the lumbar and sacral vertebræ; externally, to the angles of the ribs; and inferiorly it is blended with the tendons of the serratus posticus inferior and latissimus dorsi. When suppuration takes place in the loins, constituting a lumbar abscess in connection with spinal disease, the pus is seated beneath this aponeurosis, and is therefore tardy in coming to the surface.

Dissection. — Reflect the trapezius from its insertion. On its under surface see the ramifications of its nutrient artery, the *superficialis colli*, a branch of the posterior scapular. A large nerve, the *spinal accessory*, enters its under surface near the clavicle, and divides into filaments, which, reinforced by filaments from the third and fourth cervical nerves, are distributed to the muscle as far as its lower border.

Spinal Accessory Nerve. — This nerve, the eleventh cerebral nerve, arises by two roots — the accessory and the spinal portions: the former from the medulla, the latter from the spinal cord. The *accessory portion*, the smaller, arises by four or five filaments from a gray nucleus in the floor of the fourth ventricle, below the origin of the pneumogastric nerve; the *spinal portion* arises from the lateral part of the cervical portion of the spinal cord by several filaments, some of which arise as low as the sixth cervical vertebra, and which may be traced into the gray matter of the anterior horn. Formed by the union of these roots, the nerve enters the skull through the foramen magnum, and leaves it again, with the accessory portion, through the foramen jugulare. These portions communicate external to

the skull; but while the accessory root joins the vagus, the spinal portion, in the main, runs behind the internal jugular vein, traverses obliquely the upper third of the sterno-mastoid muscle, and crosses the posterior triangle of the neck to the trapezius, which it supplies (p. 89). In front of the trapezius it is joined by branches from the third, fourth, and fifth cervical nerves, together with which it communicates with the posterior branches of the spinal nerves.

The trapezius should now be cut through the middle, and the inner half turned inwards towards the spine, the outer half over the clavicle and the spine of the scapula.

Beneath the trapezius we have to examine the second layer, consisting of three muscles connected with the scapula; namely, the levator anguli scapulæ, the rhomboideus major and minor. The scapula should be adjusted so as to stretch their fibres.

Levator Anguli Scapulæ.—This muscle is situated at the back and side of the neck. It *arises* by four tendons from the posterior tubercles of the transverse processes of the four upper cervical vertebræ. The muscular slips to which the tendons give rise form a single muscle, which descends outwards along the side of the neck, and is *inserted* into the posterior border of the scapula between its spine and superior angle. Its *action* is to raise the posterior superior angle of the scapula; thus rotating the scapula by depressing the axillary angle, as, for instance, in shrugging the shoulders. Its *nerve* comes from the fifth cervical, and by filaments from the external series of the deep cervical plexus, which come from the third and fourth cervical nerves.

Rhomboideus Major and Minor.—These flat muscles extend from the spinous processes of the vertebræ to the base of the scapula. They often appear like a single muscle. The rhomboideus minor, the higher of the two, *arises* by a thin aponeurosis from the spinous processes of the last cervical and the first thoracic vertebræ, and is *inserted* into the base of the scapula opposite its spine. The rhomboideus major *arises* by tendinous fibres from the spinous processes of the four or five upper thoracic vertebræ and the supraspinous ligament, and is *inserted* by fleshy fibres into the base of the scapula between its spine and inferior angle, the larger number of the fibres being inserted into a tendinous arch, which is chiefly attached to the posterior inferior angle. The *action* of these muscles is to draw the scapula upwards and backwards. They are the antagonists of the serratus magnus.

The *nerve of the rhomboid muscles* (posterior scapular) is a branch of the fifth cervical. It passes outwards beneath the lower part of the levator anguli scapulæ, to which it sends a branch, and is lost in the under surface of the rhomboidei.

Omo-hyoideus. — This muscle extends from the scapula to the os hyoides, and consists of two long narrow muscular portions, connected by an intermediate tendon beneath the sterno-mastoid. The posterior portion only can be seen in the present dissection. It *arises* from the upper border of the scapula, close behind the notch, and from the transverse ligament above the notch. Thence the slender muscle passes forward across the lower part of the neck, beneath the sternoid-mastoid, where it changes its direction and ascends nearly vertically, to be attached to the os hyoides at the junction of the body with the greater cornu (Fig. 37, p. 95). Thus the two portions of the muscle form, beneath the sterno-mastoid, an obtuse angle, of which the apex is tendinous, and of which the angular direction is maintained by a layer of fascia, proceeding from the tendon to the first rib and the clavicle. Its *action* is to depress the os hyoides. Its *nerve* comes from the descendens hypoglossi and the communicantes hypoglossi (pp. 119–124).

Subscapular Artery. — This artery (transversalis humeri), a branch of the thyroid axis (Fig. 49, No. 12, p. 133), runs behind and parallel with the clavicle, over the lower end of the scalenus anticus and subclavian artery, and beneath the sterno-mastoid and omo-hyoid muscles, to the upper border of the scapula, where it usually passes above the ligament bridging over the notch. It ramifies in the supraspinous fossa, supplying the supraspinatus, and then passes under the acromion to the infraspinous fossa, where it inosculates freely with the dorsalis scapulæ, a branch of the subscapular. It sends off: —

a, The *inferior sterno-mastoid* artery to the sterno-mastoid and contiguous muscles; *b*, the *supra-acromial* branch, which ramifies upon the acromion, anastomosing with the other acromial arteries derived from branches of the axillary; *c*, a small *subscapular* branch to the fossa of the same name; *d*, *articular* arteries to the shoulder joint; and, lastly, *e*, the *infraspinous* branch, which anastomoses with the dorsalis scapulæ. The suprascapular vein terminates either in the subclavian or in the external jugular.

The *suprascapular nerve*, a branch of the fifth and sixth cervical nerves, runs with the corresponding artery, and, after passing through the suprascapular notch, is distributed to the supraspinatus and infraspinatus. In the supraspinous fossa, this nerve sends a small *articular* branch to the shoulder-joint; in the infraspinous fossa it gives off two branches to the infraspinatus, and some to the shoulder-joint.

Posterior Scapular Artery. — This artery is one of the divisions of the transversalis colli, but comes very frequently from the subclavian in the third part of its course (p. 135). It runs across the lower part of the neck, above, or between the nerves of the brachial plexus, towards the posterior superior angle of the scapula. Here it pursues its course along the posterior border of the scapula beneath the levator anguli scapulæ and the rhomboidei, anastomosing with branches of the suprascapular and subscapular arteries, and with branches from the intercostal arteries. The corresponding vein joins the external jugular or the subclavian.

Dissection. — Divide the rhomboid muscles near their insertion, and trace the artery to the inferior angle of the scapula, where it terminates in the rhomboidei, serratus magnus, and latissimus dorsi.

Numerous muscular branches arise from the posterior scapular. The *superficialis colli* (the other division of the transversalis colli) is given off near the upper angle of the scapula for the supply of the trapezius, which it enters together with the spinal accessory nerve.

Divide and reflect the latissimus dorsi below the inferior angle of the scapula, and draw the scapula forcibly outwards, to have a more perfect view of the extent of the serratus magnus than was seen in the axilla. The abundance of connective tissue in this situation is necessary for the play of the scapula on the chest.

Serratus Magnus. — This broad, thin, flat muscle intervenes between the scapula and the ribs. It *arises* by nine fleshy digitations from the eight upper ribs, each rib giving origin to one, and the second to two, and from the fascia covering the corresponding intercostal spaces. The four lower digitations correspond with those of the external oblique muscle of the abdomen. The fibres pass backwards and outwards and are arranged in three fasciculi; the upper portion *arises* from the first and second ribs and the fascia between them, and is *inserted* into the triangular surface in front of the upper angle of the scapula; the middle portion *arises* from the second, third, and fourth ribs, and is *inserted* into the inner lip of the vertebral border between the first and third portions; the third portion *arises* from the fifth, sixth, seventh, and eighth ribs, and is *inserted* into the smooth surface in front of the inferior angle; this last portion consists of four serrations, and are those which interdigitate with the external oblique.

This is the most important of the muscles which regulate the movements of the scapula. It draws the scapula forwards, and thus gives additional reach to the arm; it counteracts all forces which tend to push the scapula backwards; for instance, when a man falls forwards upon his hands, the serratus magnus sustains the shock and prevents the scapula from being driven back to the spine. Supposing the fixed point to be at the scapula, some anatomists ascribe to it the power of raising the ribs; hence Sir Charles Bell called it the external respiratory muscle, the internal respiratory muscle being the diaphragm.

The *nerve* which supplies it is a branch of the fifth and sixth cervical nerve; it descends along its outer surface, distributing a filament to each digitation of the muscle (p. 139).

Dissection. — Divide the serratus magnus near the scapula, and remove the arm by sawing through the middle of the clavicle, cutting through the axillary vessels and nerves. These should be tied to the coracoid process. After the removal of the arm examine the precise insertions of the preceding muscles.

DISSECTION OF THE MUSCLES OF THE SHOULDER.

Dissection. — The remainder of the skin over the shoulder is to be reflected, and in the subcutaneous tissue are found the cutaneous vessels and nerves. Some pass down over the shoulder, others ascend over the deltoid, emerging from beneath its lower border.

The *acromial branches* come from the third and fourth cervical nerves, and descend over the acromion (Fig. 140) in front of and behind the deltoid. The *cutaneous branch* of the *circumflex* nerve comes out beneath the posterior border of the deltoid, and supplies the skin over the posterior and outer two-thirds of the muscle; others perforate the muscle, each accompanied by a small artery.

Notice the strong layer of facia upon the surface of the deltoid, which extends from the aponeurosis covering the muscles on the back of the scapula, and is continuous with the fascia of the arm. It dips down between the fibres of the muscle, dividing it into large bundles. This fascia is to be removed by putting the deltoid on the stretch and reflecting it in the direction of its fibres, beginning from the front. The fascia will be seen to be continuous in front with the fascia covering the pec-

toralis major; above, it is attached to the clavicle and spine of the scapula; behind, it is continuous with that over the infraspinatus.

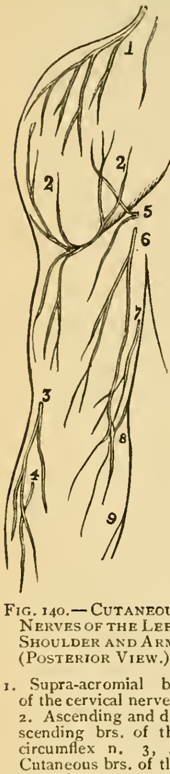


Fig. 140.—Cutaneous Nerves of the Left Shoulder and Arm. (Posterior View.)

1. Supra-acromial br. of the cervical nerves. 2. Ascending and descending brs. of the circumflex n. 3, 4. Cutaneous brs. of the musculo-cutaneous n. 5. Internal cutaneous br. of musculo-spiral n. 6. Intercosto-humeral brs. 7. Filaments of the lesser internal cutaneous n. 8. Posterior cutaneous br. of internal cutaneous n. 9. Branch of internal cutaneous n.

Deltoid.—The large muscle which covers the shoulder-joint is named deltoid from its resemblance to the Greek ∇ reversed. It *arises* from the external third of the anterior border of the clavicle, from the apex and outer border of the acromion, and from the lower border of the spine of the scapula down to the triangular surface at its root. This origin, which corresponds to the insertion of the trapezius, is tendinous and fleshy everywhere, except at the commencement of the spine of the scapula, where it is simply tendinous, and connected with the infraspinous aponeurosis. The muscular fibres descend, the anterior backwards, the posterior forwards, the middle perpendicularly; all converge to a tendon which is *inserted* into a rough surface on the outer side of the humerus, a little above the middle of the shaft (Figs. 124 and 132, pp. 324, 339). The insertion of the tendon extends one inch and a half (*3.8 cm.*) along the humerus, and terminates in a V-shaped form, the origin of the brachialis anticus embracing it on either side. Sometimes a few fibres of the pectoralis major are connected with its front border.

The muscular bundles composing the deltoid have a peculiar arrangement, a peculiarity arising from its broad origin and its narrow insertion. It consists in the interposition of tendons between the bundles for the attachment of the muscular fibres. The annexed woodcut shows this arrangement better than any description. The action of the muscle is not only concentrated upon one point, but its power is also greatly increased by this arrangement.

Action of the Deltoid.—It raises the arm; but it cannot do so beyond an angle of ninety degrees. The elevation of the arm beyond this angle is effected through the raising of the shoulder by the trapezius and serratus magnus.

Its anterior fibres draw the arm forwards; its posterior, backwards.

This powerful muscle is supplied with blood by the anterior and posterior circumflex, the thoracica humeraria, the thoracica acromialis, all from the axillary artery; also by the deltoid branch of the brachial. Its *nerve* is the circumflex.

The rotundity of the shoulder is due not so much to the deltoid as to the upper end of the humerus. When the head of the humerus is dislocated into the axilla, the fibres of the muscle run vertically to their insertion; hence the flattening of the deltoid and the greater prominence of the acromion.

It is below the deltoid that an ununited fracture of the humerus is most commonly met with, owing to the muscle displacing the upper fragment.

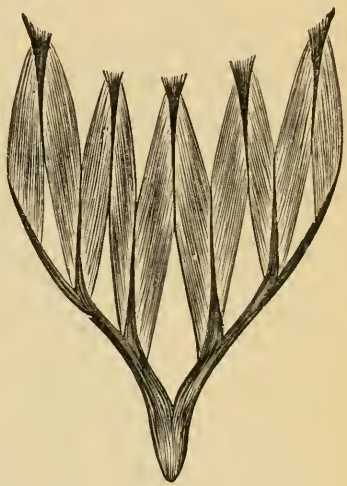


FIG. 141 — ANALYSIS OF THE DELTOID.

Dissection. — Reflect the deltoid from its origin, and turn it downwards. Observe the ramifications of the circumflex nerve and the anterior and posterior circumflex arteries on its under surface; notice also the large bursa between it and the tendons inserted into the great tuberosity of the humerus.

Parts Covered by the Deltoid. — The structures seen on reflecting the deltoid are as follows: the bursa already alluded to, the coracoid process, the coraco-acromial ligament, the origins of the biceps, and coraco-brachialis, the insertions of the pectoralis minor and major, the long head or the biceps, the insertions of the supra-spinatus, infraspinatus, and teres minor, the long and external heads of the triceps, the circumflex vessels and nerve, and the neck and upper part of the humerus.

Bursa under the Deltoid, or Subacromial. — The large bursa under the deltoid extends for some distance beneath the acromion and the coraco-acromial ligament, and covers the tendons attached to the great tuberosity of the humerus. It communicates, very rarely, with the shoulder-joint. Its use is to

facilitate the movements of the head of the bone under the acromial arch.

Posterior Circumflex Artery. — This artery is given off from the axillary in the third part of its course; it runs behind

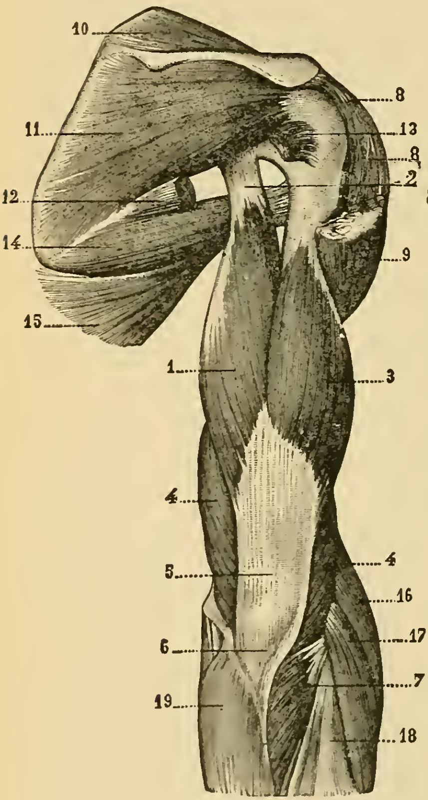


Fig. 142. — Triceps Muscle.

1. Triceps. 2. Long head of the triceps. 3. Outer head. 4. Inner head. 5. Tendon of the triceps. 6. Its attachment to the olecranon. 7. Anconeus, the fibres of which follow those of the outer head of the triceps. 8, 8. Superior part of the deltoid; the posterior half has been excised. 9. Its inferior part. 10. Supra-spinatus. 11. Infra-spinatus. 12. Origin of the teres minor. 13. Insertion of the teres minor. 14. Teres major. 15. Superior extremity of the latissimus dorsi. 16. Supinator longus or brachio-radialis. 17. Extensor carpi radialis longior. 18. Extensor carpi ulnaris. 19. Flexor carpi ulnaris.

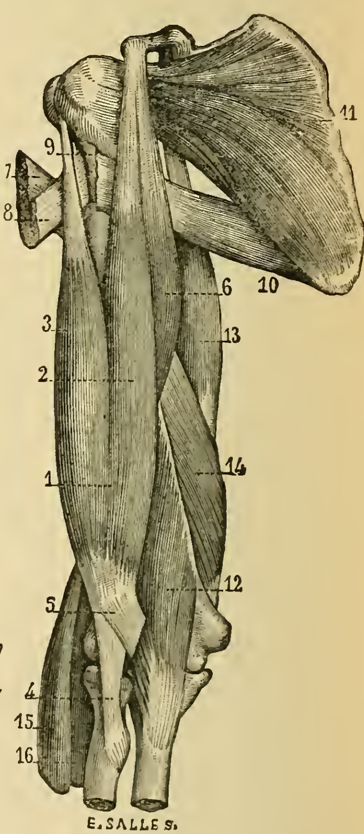


Fig. 143. — Anterior Muscles of the Arm.

1. Biceps. 2. Short head of the biceps. 3. Long head of the same. 4. Tendon attached to the tuberosity of the radius. 5. Semilunar fascial aponeurosis of the biceps. 6. Coraco-brachialis. 7, 8. The two portions of the pectoralis major forming a groove with its concavity above. 9. Attachment of the latissimus dorsi. 19. Teres major. 11. Sub-scapularis. 12. Brachialis anticus. 13. Long head of the triceps. 14. Internal head of the triceps. 15. Supinator longus or brachio-radialis. 16. Extensor carpi radialis longior.

the surgical neck of the humerus, through a quadrilateral opening, bounded above by the subscapularis and teres minor; below, by the teres major; externally, by the neck of the humerus; and internally, by the long head of the triceps (p. 380). Its branches terminate on the under surface of the deltoid, anastomosing with the anterior circumflex, acromial thoracic, and suprascapular arteries.

From the posterior circumflex a branch descends in the substance of the long head of the triceps, to inosculate with the superior profunda; this is one of the channels through which the circulation would be carried on if the axillary were tied in the last part of its course.

Circumflex Nerve. — This nerve, a branch of the posterior cord of the brachial plexus, runs with the posterior circumflex artery through the same quadrilateral space, and then divides into two branches — an upper and a lower. The *upper branch* winds round the neck of the humerus and supplies the anterior part of the deltoid, and gives off cutaneous branches to supply the skin over its lower part. The *lower branch* sends a filament to the teres minor, one or two to the integuments over the shoulder at its posterior part, and terminates in the substance of the deltoid. It also distributes an *articular* filament, which enters the shoulder-joint in front, below the subscapularis.

The proximity of this nerve to the head of the humerus explains the occasional paralysis of the deltoid, after dislocation or fracture of the humerus. The nerve is liable to be injured, if not actually lacerated, by the pressure of the bone.

A strong aponeurosis covers the muscles of the dorsum of the scapula, and is firmly attached to the spine and borders of the bone. At the dorsal edge of the deltoid it divides into two layers, one of which passes over, the other under, the muscle. Remove the aponeurosis, so far as it can be done without injury to the muscular fibres which arise from its under surface.

Infra-spinatus. — This triangular muscle *arises* by fleshy fibres from the posterior two-thirds of the infraspinous fossa, and by tendinous fibres from the ridges on the fossa, and from the aponeurosis which covers it. The fibres converge to a tendon, which is at first contained in the substance of the muscle, and then proceeds over the capsular ligament of the shoulder-joint, to be *inserted* into the middle depression on the greater tuberosity of the humerus. Its *nerve* comes from the suprascapular.

Teres Minor. — This long, narrow muscle is situated below the infraspinatus, along the inferior border of the scapula. It *arises* from the dorsum of the scapula close to the axillary border, and from the intermuscular septa between it and the infraspinatus above and the teres major below. The fibres ascend outwards parallel with those of the infraspinatus, and terminate in a tendon, which passes over the capsular ligament of the shoulder-joint, and is *inserted* into the lowest depression on the great tuberosity of the humerus, and by muscular fibres into the bone below it. It is *supplied* by a branch of the circumflex nerve, which enters the muscle at its lower border, and it has (usually) a small ganglion-like enlargement upon it.

The *action* of the infraspinatus and teres minor is to rotate the humerus outwards, and when the arm is raised it draws the humerus downwards and backwards.

Teres Major. — This muscle is closely connected with the latissimus dorsi, and extends from the inferior angle of the scapula to the humerus, contributing to form the posterior boundary of the axilla. It *arises* from the flat surface on the dorsal aspect of the inferior angle of the back of the scapula, from its axillary border, and the intermuscular septa, and terminates in a flat tendon, nearly two inches (*5 cm.*) in breadth, which is *inserted* into the inner edge of the bicipital groove of the humerus, behind and a little lower than the tendon of the latissimus dorsi. Its *action* is to draw the humerus backwards and downwards when the arm is raised, and to rotate it slightly inwards. It is *supplied* by the middle subscapular nerve, which enters it on its axillary aspect.

A bursa is found in front of, and another behind, the tendon of the teres major; the former separates it from the latissimus dorsi, the latter from the bone.

Supra-spinatus. — This muscle *arises* from the posterior two-thirds of the supraspinous fossa, and from its aponeurotic covering. It passes under the acromion, over the capsular ligament of the shoulder-joint, and is *inserted* by a strong tendon into the superior depression on the greater tuberosity of the humerus. To see its insertion, the acromion should be sawn off near the neck of the scapula. Its *action* is to assist the deltoid in raising the arm. It is *supplied* by two branches derived from the subscapular nerve.

Subscapularis. — This triangular fleshy muscle occupies the subscapular fossa. It *arises* from the posterior three-fourths of

the fossa, except the vertebral border and angles which give attachment to the serratus magnus, and from three or four tendinous septa attached to the oblique bony ridges on its surface. The fibres, passing upwards and outwards, converge towards the neck of the scapula, where they terminate in three or four tendons, which are concealed amongst the muscular fibres, and are *inserted* into the lesser tuberosity of the humerus and into the bone for an inch below the tuberosity. Its broad insertion is closely connected with the capsule of the shoulder-joint, which it completely protects upon its inner side. Its *action* is to rotate the humerus inwards, and, when the arm is raised, draws it downwards. The *nerves* which supply it come from the long and middle subscapular nerves.

The coracoid process, with the coraco-brachialis and short head of the biceps, forms an arch, under which the tendon of the subscapularis plays. There are several *bursæ* about the tendon. One, of considerable size, on the upper surface of the tendon, facilitates its motion beneath the coracoid process and the coraco-brachialis; this sometimes communicates with the large bursa under the deltoid. Another is situated between the tendon and the capsule of the joint, and almost invariably communicates with it.

Dissection. — Now reflect the muscles from the surfaces of the scapula, to trace the arteries which ramify upon it.

Continuation of Suprascapular Artery and Nerve. — This artery, a branch of the thyroid axis, runs under and parallel with the clavicle, and passes above the notch of the scapula into the supraspinous fossa; it sends a branch to the supraspinatus, another to the shoulder-joint, and then descends behind the neck of the scapula into the fossa below the spine, where it inosculates directly with the dorsalis scapulæ. Its branches ramify upon the bone, and supply the infraspinatus and teres minor (Fig. 144).

The suprascapular nerve passes most frequently through the notch of the scapula, accompanies the corresponding artery, supplies two branches to the supraspinatus and one to the shoulder-joint; it then enters the infraspinous fossa, to terminate in the infraspinatus.

Dorsalis Scapulæ Artery. — This artery, after passing through the triangular space (p. 319), curves round the inferior border of the scapula, which it grooves, to the infraspinous fossa, where it ascends close to the bone, and anastomoses with

the supra and posterior scapular arteries. Another branch of the subscapular artery runs between the teres minor and major towards the inferior angle of the scapula, where it anastomoses with the posterior scapular artery (Fig. 144).

The several communications above the scapula, between the branches of the subclavian and axillary arteries, would furnish a large collateral supply of blood to the arm, if the subclavian were tied above the clavicle (p. 137).

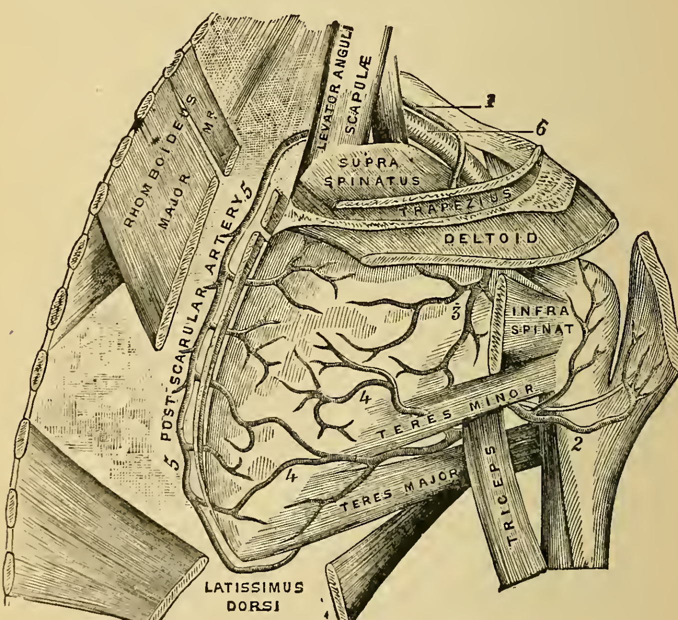


FIG. 144.—DIAGRAM OF ARTERIES OF SCAPULA.
1. Suprascapular artery. 2. Posterior circumflex a. 3. Infraspinous br. of suprascapular a. 4. Dorsalis scapulæ a. 5. Posterior scapular a. 6. Subclavian a.

Dissection. — If the skin has not been reflected from the back of the arm it should now be done. In the subcutaneous tissue will be seen the *internal cutaneous branch* of the *musculo-spiral* nerve, which supplies the skin as low down as the olecranon. On the inner side of this branch is the *intercosto-humeral nerve*, supplying the skin as far as the lower third of the arm. The *nerve of Wrisberg* also supplies the lower third of the arm ; and on the outer side for the same distance is the *external cutaneous* branch of the *musculo-spiral* nerve.

The fascia is now to be removed, when the triceps will be exposed, forming the only muscle on the back of the arm.

Triceps Extensor Cubiti. — This muscle, which arises by three distinct heads, and was only partially seen in the dissection of the upper arm (p. 339), should now be thoroughly examined (Fig. 143, p. 380). The *long head arises* immediately below the glenoid cavity of the scapula, by a strong, flat tendon, which is connected with the capsular and glenoid ligaments of the shoulder-joint. The *external head arises* from the posterior part of the humerus, below the insertion of the teres minor, as far as the musculo-spiral groove, from the outer border of the humerus, and the external intermuscular septum. The *internal head arises* from the posterior part of the humerus, below the teres major and the musculo-spiral groove, as far as the olecranon fossa; it has an additional origin from the internal intermuscular septum, and from the internal border of the humerus. The precise origin of these heads from the humerus may be ascertained by following the superior profunda artery and musculo-spiral nerve, which separate them. The three portions of the muscle terminate upon a broad tendon, which covers the back of the elbow-joint, and is *inserted* into the summit and sides of the olecranon; it is also connected with the fascia on the back of the forearm. The effect of this connection is that the same muscle which extends the forearm tightens the fascia which gives origin to the extensors of the wrist and fingers. The same holds good in the case of the biceps, and its semilunar expansion in the fascia of the forearm.

Between the tendon and the olecranon is a *bursa*, commonly of small size, but sometimes so large as to extend upwards behind the capsule of the joint. This bursa must not be mistaken for the subcutaneous one, which is situated between the skin and the olecranon, and is so often injured by a fall on the elbow.

Dissection. — By dividing the triceps transversely a little above the elbow, and turning down the lower portion, it will be seen that some of the muscular fibres terminate upon the capsular ligament of the joint. They have been described as a distinct muscle, under the name of the *subanconeus;* their use is to draw up the capsule so that it may not be injured during extension of the arm. The subanconeus is, in this respect, analagous to the subcrureus muscle of the thigh. Observe the *bursa* under the tendon, and the arterial arch formed upon

the back part of the capsule by the superior profunda and the anastomotica magna (Fig. 147, p. 396).

Trace the continuation of the superior profunda artery (p. 334) and musculo-spiral nerve round the posterior part of the humerus. They lie in a slight groove on the bone,* between the external and internal heads of the triceps, and are protected by an aponeurotic arch thrown over them by the external head of the triceps. After supplying the muscles, the artery continues its course along the outer side of the arm between the brachialis anticus and supinator radii longus, and inosculates with the radial recurrent. It gives off a branch, which runs down between the triceps and the bone, and inosculates, at the back of the elbow, with the anastomotica magna and posterior interosseous recurrent. The musculo-spiral nerve which accompanies the artery sends branches to supply the three portions of the triceps, the supinator radii longus or brachio-radialis, and extensor carpi radialis longior.† It then divides into the posterior interosseous and radial nerves. The small nerve must be made out which runs down in the substance of the triceps, accompanied by a branch from the superior profunda artery, to supply the anconeus. The cutaneous branches of the musculo-spiral nerve have been already dissected (p. 327).

DISSECTION OF THE BACK OF THE FOREARM.

Subcutaneous Bursæ. — Remove the skin from the back of the forearm, hand, and fingers, and make out the subcutaneous *bursa* over the olecranon. It is of considerable size, and, if distended, would appear nearly as large as a walnut. Another *bursa* is sometimes found a little lower down upon the ulna. A subcutaneous *bursa* is generally placed over the internal condyle, another over the external. A *bursa* is also situated over the styloid process of the ulna; this sometimes communicates with the sheath of the extensor carpi ulnaris. Small *bursæ* are sometimes developed in the cellular tissue over each of the knuckles.

The cutaneous veins from the back of the hand and forearm join the venous plexus at the bend of the elbow (see p. 327).

* It is worth remembering that the nerve may be injured by a fracture of the humerus in this situation, and even by too tight bandaging; the result being paralysis of the extensor muscles of the forearm.

† The brachialis anticus usually receives a branch from the musculo-spiral nerve.

Cutaneous Nerves of the Back of the Forearm. — The cutaneous nerves of the back of the forearm are derived from the external cutaneous branches of the musculo-spiral, from branches of the internal cutaneous, and of the external cutaneous nerves. The greater number of these nerves may be traced down to the back of the wrist.

Nerves on the Back of the Hand and Fingers. — The skin on the back of the hand is united to the subjacent tendons by an abundance of loose connective tissue, in which are large veins, and branches of the radial and ulnar nerves. The *dorsal branch* of the *ulnar nerve* passes beneath the tendon of the flexor carpi ulnaris, pierces the fascia just above the wrist-joint, runs over the posterior annular ligament of the wrist, and divides upon the back of the hand into filaments, which supply both sides of the back of the little finger, the ring finger, and the ulnar side of the middle finger. The *radial nerve* passes obliquely beneath the tendon of the brachio-radialis, perforates the fascia about two inches (*5 cm.*) above the wrist-joint, and subdivides into filaments, which supply both sides of the back of the thumb and forefinger, and the radial side of the middle finger.* (Fig. 135, p. 350.)

The radial nerve commonly gives off, on the back of the hand, a branch which joins the nearest branch of the ulnar.

Fascia on Back of Forearm. — The fascia on the back of the forearm is composed of fibres interlacing and stronger than that upon the front of the forearm. It is attached to the condyles of the humerus and to the olecranon, and is strengthened by an expansion from the tendon of the triceps. Along the forearm it is attached to the ridge on the posterior part of the ulna. Its upper third gives origin to the fibres of the muscles beneath it, and divides them by septa, to which their fibres are also attached.

Posterior Annular Ligament. — This ligament should be considered as a part of the fascia of the forearm, specially strengthened by oblique aponeurotic fibres on the back of the wrist, to confine the extensor tendons. These fibres are at-

* The relative share which the radial and ulnar nerves take in supplying the fingers varies. Under any arrangement the thumb and each finger has two dorsal nerves, one on either side, of which the terminal branches reach the root of the nail. They supply filaments to the skin on the back of the finger, and have frequent communications with the palmar digital nerves. In some instances one or more of the dorsal nerves do not extend beyond the first phalanx; their place is then supplied by a branch from the palmar nerve.

tached to the outer margin of the radius, and thence pass obliquely inwards to the inner side of the wrist, where they are connected with the pisiform and cuneiform bones. They pass below the styloid process of the ulna, to which they are in no way attached, otherwise the rotation of the radius would be impeded.

Separate Sheaths for Extensor Tendons.—From the deep surface of the posterior annular ligament, processes are attached to the ridges on the back of the radius, so as to form six distinct fibro-osseous sheaths for the passage of the extensor tendons. Commencing from the radius, the first sheath contains the tendons of the extensor ossis metacarpi and the extensor brevis pollicis or extensor primi internodii pollicis; the second, the tendons of the extensor carpi radialis longior and brevior; the third, the tendon of the extensor longus pollicis or extensor secundi internodii pollicis; the fourth, the tendons of the extensor indicis and the extensor communis digitorum; the fifth, the tendon of the extensor minimi digiti; and the sixth, the tendon of the extensor carpi ulnaris. All the sheaths are lined by synovial membranes, which extend nearly to the insertions of their tendons. Occasionally, but not often, one or more of them communicate with the wrist-joint.

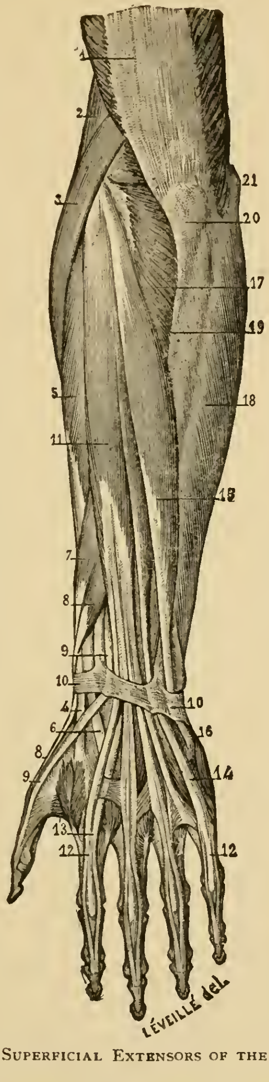
The *fascia of the metacarpus* consists of a thin fibrous layer continued from the posterior annular ligament. It separates the extensor tendons from the subcutaneous veins and nerves, and is attached to the radial side of the second metacarpal bone, and the ulnar side of the fifth.

Dissection.—The fascia must be removed from the muscles, without injuring the muscular fibres which arise from its under surface. Preserve the posterior annular ligament.

Superficial Muscles on the Back of the Forearm.—The following superficial muscles are now exposed, and should be examined in the order in which they are placed, proceeding from the radial to the ulnar side: 1. The brachio-radialis already described (p. 347). 2. The extensor carpi radialis longior. 3. The extensor carpi radialis brevior. 4. The extensor communis digitorum. 5. The extensor minimi digiti. 6. The extensor carpi ulnaris. 7. The anconeus.

A little below the middle of the forearm, the extensors of the wrist and fingers diverge from each other, leaving an interval, in which are seen the three extensors of the thumb—namely, the extensor ossis metacarpi pollicis, the extensor brevis pollicis,

and the extensor longus pollicis. The two former cross obliquely over the radial extensors of the wrist, and pass over the



1. Tendon of the triceps.
2. Origin of the supinator longus or brachio-radialis.
3. Extensor carpi radialis longior.
4. Insertion of this muscle.
5. Extensor radialis brevior.
6. Insertion of this muscle.
7. Extensor ossis metacarpi pollicis.
8, 8. Extensor brevis or primi internodii pollicis.
9, 9. Extensor longus or secundi internodii pollicis.
10, 10. Posterior annular ligament.
11. Extensor communis digitorum.
12, 12. Attachments of the tendons of this muscle to the middle and distal phalanges of the four fingers.
13. Tendons of the extensor indicis uniting with the tendon of the communis digitorum indicis.
14. Tendon of the extensor minimi digiti mingling posteriorly with the tendon of the communis to the little finger.
15. Extensor carpi ulnaris.
16. Its insertion into the metacarpal bone.
17. Anconeus.
18. Flexor carpi ulnaris attached to the posterior border of the ulna by the aponeurosis.

FIG. 145.—SUPERFICIAL EXTENSORS OF THE FOREARM.

lower third of the radius; the latter emerges from under the radial border of the extensor communis digitorum, and then

passes over the insertions of the tendons of the radial extensors of the wrist.

Between the second and third extensors of the thumb, we observe a part of the lower end of the radius, which is not covered either by muscle or tendon. This subcutaneous portion of the bone is immediately above the prominent tubercle in the middle of its lower extremity, and, since it can be easily felt through the skin, it presents a convenient place for examination in doubtful cases of fracture.

Extensor Carpi Radialis Longior. — This muscle is partly covered by the supinator radii longus. It *arises* from the lower third of the ridge leading to the external condyle of the humerus, and from the intermuscular septum. It descends along the outer side of the forearm, and terminates about the middle, in a flat tendon, which passes beneath the extensor ossis metacarpi and brevis pollicis, traverses a groove on the outer and back part of the radius, lined by a synovial membrane, and is *inserted* into the radial side of the carpal end of the metacarpal bone of the index finger. Previous to its insertion, the tendon is crossed by the extensor longus pollicis. It is *supplied* by a branch from the musculo-spiral nerve (Fig. 145, No. 3, p. 389). Its *action* is to extend the wrist, slightly to abduct it. When the wrist is fixed it will assist to flex the forearm.

Extensor Carpi Radialis Brevior. — This muscle *arises* from the external condyle by the tendon common to it and the other extensors, from the intermuscular septa, from the external lateral ligament of the elbow-joint and the aponeurosis covering the muscle. The muscular fibres terminate near the lower third of the forearm, upon the under surface of a flat tendon, which descends, covered by that of the extensor carpi radialis longior, beneath the three extensors of the thumb. The tendon traverses a groove on the back of the radius, on the same plane with that of the long radial extensor, but lined by a separate synovial membrane, and is *inserted* into the radial side of the base of the metacarpal bone of the middle finger. A bursa is generally found between the tendon and the bone. Its *nerve* comes from the posterior interosseous (Fig. 145, No. 5, p. 389). *Action* similar to the longior.

Extensor Communis Digitorum. — This muscle *arises* from the common tendon attached to the external condyle, from the septa between it and the contiguous muscles, and from its strong facial covering. A little below the middle of the forearm, the

muscle divides into three tendons, which pass, together with the extensor indicis, beneath the posterior annular ligament, through a groove on the back of the radius lined by synovial membrane. On the back of the hand the tendons become broader and flatter, and diverge from each other towards the metacarpal joints of the fingers, where they become thicker and narrower, and give off, on each side, a fibrous expansion, which covers the sides of the joint. Over the first phalanx of the finger, each tendon again spreads out, receives the expanded tendons of the lumbricales and interossei muscles, and divides at the second phalanx into three portions, of which the middle is *inserted* into the upper end of the second phalanx; the two lateral, reuniting over the lower end of the second phalanx, are *inserted* into the upper end of the third.* Its *nerve* comes from the posterior interosseous. (Fig. 145, No. 11, p. 389.)

The oblique aponeurotic slips which connect the tendons on the back of the hand are subject to great variety. The tendon of the index finger is commonly free; it is situated on the radial side of the proper indicator tendon, and becomes united with it at the metacarpal joint.

The tendon of the middle finger usually receives a slip from that of the ring. The tendon of the ring finger generally sends a slip to the tendons on either side of it, and, in some cases, entirely furnishes the tendon of the little finger. Thus the ring finger does not admit of independent extension.†

The muscle is not only a general extension of the fingers, but can extend some of the phalanges independently of the rest: *e. g.*, it can extend the first phalanges while the second and third are flexed, the extension of the second and third being performed by the lumbricales. It is supplied by the musculo-spiral *nerve.*

Extensor Minimi Digiti, or Auricularis. — This long, slender muscle, situated on the ulnar side of the common extensor, *arises* from the common tendon from the external con-

* The extensor tendons are inserted into the periosteum; but the flexor tendons are inserted into the substance of the bone. This accounts for the facility with which the former will tear off the bones in cases of necrosis, while the latter will adhere so tightly as to require cutting before the phalanx can be removed. It probably also explains the great liability to necrosis which is so frequently observed in cases of thecal abcess.

† Hence, subcutaneous tenotomy of the web uniting these extensor tendons greatly facilitates the piano and flute players, without impairing the strength of their extensile power. — A. H.

dyle, and from the septa between it and the contiguous muscles. Its slender tendon runs separately beneath the annular ligament immediately behind the joint between the radius and ulna, in a special sheath lined by synovial membrane. On emerging from the annular ligament, the tendon splits into two, which pass obliquely to the little finger. At the first joint of the little finger, the outer tendon is joined by that of the common extensor, and both expand upon the first and second phalanges, terminating in the same manner as the extensor tendons of the other fingers. Its *nerve* comes from the posterior interosseous, from the musculo-spiral. Its *action* is similar to the communis digitorum, but confined to this digit. (Fig. 145, No. 14, p. 389.)

Extensor Carpi Ulnaris. — This muscle *arises* from the common tendon from the external condyle, from the septum between it and the extensor minimi digiti, from the fascia of the forearm, and from the aponeurosis attached to the posterior ridge of the ulna common to this muscle, the flexor carpi ulnaris, and the flexor profundis digitorum. The fibres terminate upon a strong, broad tendon, which traverses a distinct groove on the back of the ulna, close to the styloid process, and is *inserted* into the dorsal aspect of the carpal end of the fifth metacarpal bone. Below the styloid process of the ulna, the tendon passes beneath the posterior annular ligament, over the back of the wrist, and is confined in a very strong fibrous canal, which is attached to the back of the cuneiform, pisiform, and unciform bones, and is lined by a continuation from the synovial membrane in the groove of the ulna. The *action* of this muscle is to extend the hand, and adduct the wrist especially in pronation. It is *supplied* by the posterior interosseous nerve. (Fig. 145, No. 15, p. 389.)

In pronation of the forearm the lower articular end of the ulna projects between the tendons of the extensor carpi ulnaris and the extensor minimi digiti. A subcutaneous *bursa* is sometimes found above the bone in this situation.

Anconeus. — This small triangular muscle is situated at the outer and back part of the elbow. It is covered by a strong layer of fascia, derived from the tendon of the triceps, and appears like a continuation of that muscle. It *arises* by a tendon from the posterior part of the external condyle of the humerus, and is *inserted* into the triangular surface on the upper fourth of the outer part of the ulna. Part of the under surface of the

muscle is in contact with the capsule of the elbow-joint. Its *action* is to assist in extending the forearm. Its *nerve* comes from the musculo-spiral (Fig. 146, No. 3, p. 394).

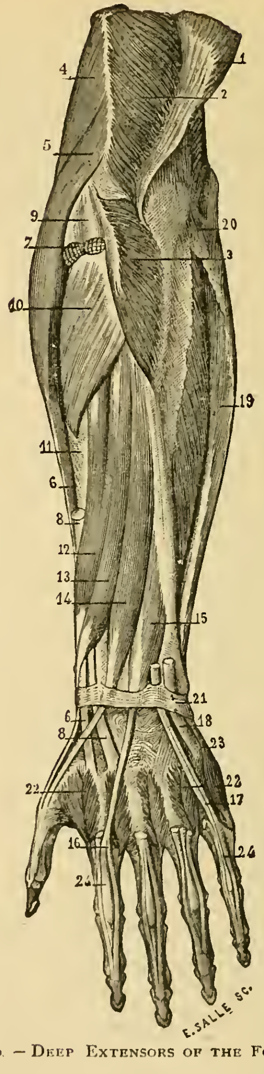
Dissection. — To expose the deep layer of muscles detach from the external condyle the extensor carpi radialis brevior, the extensor communis digitorum, the extensor minimi digiti, and the extensor carpi ulnaris; and, after noticing the vessels and nerves which enter their under surface, turn them down.

Deep-seated Muscles on the Back of the Forearm. — The deep-seated muscles, with the posterior interosseous artery and nerve, must be dissected. The muscles exposed are: 1. The extensor ossis metacarpi pollicis. 2. Extensor brevis pollicis. 3. Extensor longus pollicis. 4. Extensor indicis or indicator. 5. The supinator radii brevis. They are all supplied by branches from the posterior interosseous nerve.

Extensor Ossis Metacarpi Pollicis. — This muscle lies immediately below the supinator brevis, and *arises* from the posterior surface of the ulna below the supinator brevis, from the posterior surface of the middle third of the radius, and from the interosseous membrane. The muscle passes obliquely downwards and outwards, crosses the radial extensors of the wrist about three inches (*7.5 cm.*) above the carpus, and terminates in a tendon, which passes along a common groove with the extensor brevis pollicis, lined by synovial membrane, on the outer part of the lower end of the radius, and is *inserted* into the base of the metacarpal bone of the thumb, to the abductor pollicis * and frequently also by a tendinous slip into the trapezium (Fig. 146, No. 12, p. 394). Its *action* is to abduct and extend the first metacarpal bone. Its *nerve* is from the musculo-spiral through the posterior interosseus.

Extensor Brevis, or Primi Internodii Pollicis. — This, the smallest of the deep muscles, *arises* from the middle posterior surface of the radius, below the preceding, and from the interosseus membrane. It descends obliquely in company with the preceding muscle, turns over the radial extensors of the wrist, and terminates upon a tendon which passes beneath the annular ligament, through the groove on the outer part of the radius, and is *inserted* into the radial side of the base of the first and second * phalanges of the thumb (Fig. 146, No. 13, p. 394). Its *action* is to extend the first and second phalanges, and assists

* Boylston Prize Essay, Walsh, 1897.



1. Tendon of the triceps.
2. External head of the triceps.
3. Anconeus.
4. Origin of supinator longus, or brachio-radialis.
5. Origin of the extensor carpi radialis longior.
6, 6. Tendon of this muscle inserted into the index metacarpal.
7. Origin of the extensor carpi radialis brevior.
8, 8. Tendon of this muscle inserted into the base of the metacarpal bone of the middle finger.
9. Common tendon of origin for the superficial layer of muscles.
10. Supinator brevis.
11. Insertion of the pronator radii teres.
12. Extensor ossis metacarpi pollicis.
13. Extensor brevis or primi internodii pollicis.
14. Extensor longus, or secundi internodii pollicis.
15. Extensor indicis.
16. Tendon of the muscle uniting with the corresponding tendon of the extensor communis.
17. Tendon of the extensor minimi digiti uniting with the corresponding tendon of the extensor communis.
18. Tendon of extensor carpi ulnaris.
19. Flexor carpi ulnaris.
20. Fibrous arch extending from the epitrochlea to the olecranon process, forming the superior origin of the flexor carpi ulnaris.
21. Posterior annular ligament.
22. Dorsal interossii.
23. Abductor minimi digiti.
24, 24. Tendons of the extensor communis digitorum.

FIG 146. — DEEP EXTENSORS OF THE FOREARM.

the preceding muscles in abduction of the thumb. Its *nerve* is the posterior interosseous from the musculo-spiral.

Extensor Longus, or Secundi Internodii Pollicis. — This muscle covers part of the origin of the preceding muscle, and *arises* from the posterior surface of the ulna, below the extensor

ossis metcarpi pollicis, and from the interosseous membrane. The tendon receives fleshy fibres as low as the wrist, passes beneath the annular ligament in a distinct groove on the back of the radius, crosses the tendons of the radial extensors of the wrist, proceeds over the metacarpal bone and the first phalanx of the thumb, and is *inserted* into the base of the last phalanx (Fig. 146, No. 14, p. 394).

The tendons of the three extensors of the thumb may be easily distinguished in one's own hand. The extensor ossis metacarpi and brevis pollicis cross obliquely over the radial artery, where it lies on the external lateral ligament of the carpus; the extensor longus pollicis crosses the artery just before it sinks into the palm, between the first and second metacarpal bones, and is a good guide to the vessel. Its *action* is primarily to extend the second phalanx, secondarily the first phalanx, and finally the whole thumb. It assists in radial extension of the hand and in slight supination.

Its *nerve* is the posterior interosseus from the musculospiral.

Extensor Indicis, or Indicator. — This muscle *arises* from the posterior surface of the ulna, below the extensor longus pollicis, and slightly from the interosseous membrane. The tendon passes beneath the posterior annular ligament, in the same groove, on the back of the radius, with the tendons of the extensor digitorum communis. It then proceeds over the back of the hand to the first phalanx of the index finger, where it is united to the ulnar border of the common extensor tendon. By the *action* of this muscle the index finger can be extended independently of the others adducting and abducting the finger when the common extensor is in tension (Fig. 146, No. 15, p. 394).

Dissection. — Reflect the anconeus from its origin to expose the following muscle: —

Supinator Radii Brevis. — This muscle embraces the upper third of the radius. It *arises* from the external condyle of the humerus, from the external lateral ligament of the elbow-joint, from the orbicular ligament surrounding the head of the radius, from an oblique ridge on the outer surface of the ulna below the insertion of the anconeus, by fleshy fibres from the triangular excavation below the lesser sigmoid notch of the ulna, and from the aponeurosis covering the muscle. The muscular fibres turn over the neck and upper part of the shaft of the

radius, and are *inserted* into the upper third of this bone as far forwards as the ridge leading from the tubercle to the insertion of the pronator teres. The muscle is traversed obliquely by the posterior interosseus nerve, which sends a branch to it, and its upper part is in contact with the capsule of the elbow-joint. It is a powerful supinator* of the forearm, some of its fibres acting at nearly a right angle to the axis of the radius (Fig. 146, No. 10, p. 394). Its *nerve* is the posterior interosseous from the musculo-spiral.

FIG. 147.—DIAGRAM SHOWING THE ANASTOMOSES OF ARTERIES AT THE BACK OF THE ELBOW AND WRIST JOINTS.

1. The superior profunda. 2. The anastomotica magna. 3. The posterior ulnar recurrent. 4. The posterior interosseous, its ascending and descending branches. 5. The termination of the anterior interosseous. 6 The posterior carpal arch.

Posterior Interosseous Artery.—This artery comes from the ulnar by a common trunk with the anterior interosseous and supplies the muscles on the back of the forearm. It passes between the oblique ligament and the interosseous membrane, and appears, at the back, between the supinator radii brevis and the extensor ossis metacarpi pollicis. After supplying branches to all the muscles in this situation, the artery descends, much diminished in size, between the superficial and deep layer of muscles to the wrist, where it inosculates with the carpal branches of the anterior interosseous and the posterior carpal branches of the radial and ulnar arteries.

The largest branch of this artery is the *interosseous recurrent.* It ascends beneath the supinator brevis and the anconeous to the space between the external condyle and the olecranon, where it inosculates with the branch of the superior profunda, which descends in the substance of the triceps, with the posterior ulnar recurrent artery, and with the anastomotica magna.

In the lower part of the back of the forearm a branch of the anterior interosseous artery is seen passing through the interosseous membrane to reach the back of the wrist.

Posterior Interosseous Nerve.—The nerve which supplies the muscles on the back of the forearm is the *posterior interosseous*, one of the divisions of the musculo-spiral. It passes obliquely through the supinator radii brevis, and descends, lying on the lower fibres of this muscle, the extensores ossis

* As the muscle is able to turn the radius nearly 180 degrees, great care should be taken in fracture of the upper third of this bone to place the lower fragment in extreme supination to preserve the pronating and supinating function of the forearm. Especially is it to be remembered that the biceps assist in supination, and all antagonizing force is removed in this fracture.—A. H.

metacarpi and brevis pollicis, and beneath the superficial extensors. It then, much diminished in size, passes under the extensor longus pollicis, on the interosseous membrane, as far as the posterior annular ligament, where it presents a gangliform enlargement. Between the superficial and deep layer of muscles it sends to each a filament, generally in company with a branch of the posterior interosseous artery. It sends a branch to the extensor carpi radialis brevior, and supplies the supinator brevis in passing through its substance. The brachio-radialis and the extensor carpi radialis longior are supplied by distinct branches from the musculo-spiral nerve.

After the posterior interosseous nerve descends beneath the extensor longus pollicis, it lies on the interosseous membrane, beneath the extensor digitorum communis and the indicator. At the back of the wrist, beneath the annular ligament, it forms the gangliform enlargement from which filaments are sent to the carpal and metacarpal joints.

Dissection. Radial Artery on the Back of the Wrist. — The radial artery is continued over the external lateral ligament of the carpus, beneath some filaments of the radial nerve, cutaneous veins, and the extensor tendons of the thumb, to the proximal part of the interval between the first and second metacarpal bones, where it dips down between the two origins of the abductor indicis, and, entering the palm, forms the deep palmar arch. In this part of its course it is accompanied by a filament of the musculo-cutaneous nerve; observe also that the tendon of the extensor longus pollicis passes over it immediately before it sinks into the palm. It supplies in this part of its course the following small branches to the back of the hand: —

a. Posterior carpal artery. — This branch passes across the carpal bones beneath the extensor tendons. It inosculates with the termination of the anterior interosseous artery, and forms an arch beneath the extensor tendons, with a corresponding branch from the ulnar artery. The carpal arch sends off small branches, called the *dorsal interosseous*, which descend along the third and fourth interosseous spaces from the arch just mentioned, beneath the extensor tendons, and inosculate near the carpal ends of the metacarpal bones with the perforating branches from the deep palmar arch.

b. The *first dorsal interosseous artery* is generally larger than the others. It passes forwards, beneath the extensors of the thumb, on the second interosseous space to the cleft between the index and middle fingers, communicating here with a perforating branch of the deep palmar arch, and terminates in small branches, some of which proceed along the back of the fingers, others inosculate with the palmar digital arteries.

c. The *dorsalis indicis*, a branch of variable size, passes over the first interosseous muscle along the radial side of the back of the index finger.

d. The *dorsales pollicis* are two small branches which arise from the radial opposite the head of the first metacarpal bone, and run along the back of the thumb, one on either side. They are often absent.

These dorsal interosseous arteries supply the extensor tendons and their sheaths, the interosseous muscles, and the skin on the back of the hand and the first phalanges of the fingers.

Dissection. — Remove the tendons from the back and from the palm of the hand; observe the deep palmar fascia which

covers the interosseous muscles. It is attached to the ridges of the metacarpal bones, forms a distinct sheath for each interosseous muscle, and is continuous inferiorly with the transverse metacarpal ligament. On the back of the hand the interosseous muscles are covered by a thin fascia, which is attached to the adjacent borders of the metacarpal bones.

Transverse Metacarpal Ligament. — This consists of strong bands of ligamentous fibres, which pass transversely between the distal extremities of the metacarpal bones. These bands are intimately united to the fibro-cartilaginous ligament of the metacarpal joints, and are of sufficient length to admit of a certain degree of movement between the ends of the metacarpal bones.

Dissection. — Remove the fascia which covers the interosseous muscles, and separate the metacarpal bones by dividing the transverse metacarpal ligament. A *bursa* is frequently developed between their digital extremities.

Interosseous Muscles. — These muscles, so named from their position, extend from the sides of the metacarpal bones to the bases of the first phalanges and the extensor tendons of the fingers. In each interosseous space (except the first, in which there is only an abductor) there are two muscles, one of which is an abductor, the other an adductor, of a finger. Thus there are *seven* in all, four of which, situated on the back of the hand, are called dorsal; the remainder, seen only in the palm, are called palmar.* They are all supplied by the ulnar nerve.

Dorsal Interossei. — Each dorsal interosseous is a bipenniform muscle, and *arises* from the opposite sides of two contiguous metacarpal bones (Figs. 148 and 149). From this double origin the fibres converge to a tendon, which passes between the metacarpal joints of the finger, and is *inserted* into the side of the base of the first phalanx, and by a broad expansion into the extensor tendon on the back of the same finger.

The *first dorsal interosseous* muscle (*abductor indicis*) is larger than the others, and occupies the interval between the thumb and forefinger. It *arises* from the proximal half of the ulnar side of the first metacarpal bone, and from the entire length of the radial side of the second: between the two origins, the radial artery passes into the palm. Its fibres converge on either

* If we consider the adductor pollicis as a palmar interosseous muscle, there would be four palmar and four dorsal — all supplied by the ulnar nerve.

side to a tendon, which is *inserted* into the *radial* side of the first phalanx of the index finger, and its extensor tendon.

The *second dorsal interosseous* muscle occupies the second metacarpal space. It is *inserted* into the radial side of the first phalanx of the middle finger and its extensor tendon.

The *third* and *fourth*, occupying the corresponding metacarpal spaces, are *inserted*, the one into the ulnar side of the middle, the other into the ulnar side of the ring finger (Fig. 146, No. 22, p. 394).

If a line be drawn longitudinally through the middle finger, as represented by the dotted line in Fig. 149, we find that all

Fig. 148.—Diagram of the Four Dorsal Interossei, Drawing from the Middle Line.

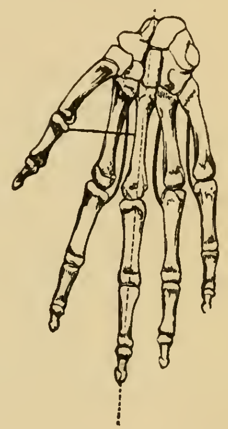


Fig. 149.—Diagram of the Three Palmar Interossei, and the Adductor Pollicis, Drawing Towards the Middle Line.

the dorsal interosseous muscles are abductors from that line; consequently they separate the fingers from each other.

Palmar Interosseous. — It requires a careful examination to distinguish this set of muscles, because the dorsal muscles protrude with them into the palm. They are smaller than the dorsal, and each *arises* from the lateral surface of only one metacarpal bone — that, namely, connected with the finger into which the muscle is inserted (Fig. 149). They terminate in small tendons, which pass between the metacarpal joints of the fingers, and are *inserted*, like those of the dorsal muscles, into the sides of the first phalanges and the extensor tendons on the back of the fingers.

The *first palmar interosseous* muscle *arises* from the ulnar side of the second metacarpal bone, and is *inserted* into the ulnar side of the index finger. The *second* and *third* arise, the one from the radial side of the fourth, the other from the radial side of the fifth metacarpal bone, and are *inserted* into the same sides of the ring and little fingers.

The palmar interosseous muscles are all adductors to a line drawn through the middle finger (Fig. 149). They are, therefore, the opponents of the dorsal interosseous, and move the fingers towards each other.*

The palmar and dorsal interossei are *supplied* by filaments from the deep branch of the ulnar nerve (Fig. 131, No. 36, p. 337).

DISSECTION OF THE LIGAMENTS.

Sterno-clavicular Joint. — The inner end of the clavicle articulates with the comparatively small and shallow excavation on the upper and outer part of the sternum, and is an arthrodial joint. The security of the joint depends upon the great strength of its ligaments. There are two synovial membranes, and an intervening fibro-cartilage.

The *anterior sterno-clavicular ligament* (Fig. 150) consists of a lax, strong, broad band of ligamentous fibres, which pass obliquely downwards and inwards over the front of the joint, from the inner end of the clavicle to the anterior surface of the sternum.

* The interossei, probably, also assist the flexors of the fingers when the latter are slightly flexed at their metacarpo-phalangeal joints. M. Duchenne believes that, in addition to their usually ascribed function of abduction, adduction, and supplemental flexion at the metacarpo-phalangeal articulation, the interossei act as extensors of the second and third phalanges; the common extensor tendons acting only as extensors of the first phalanges. (*Physiologie des Mouvements, etc.*, 1867). The action of the lumbricales in extending the second and third phalanges (even if they are not the chief factors of this movement) must not be lost sight of, for in a case, recorded in *St. Bartholomew's Hospital Reports*, 1881, in which the ulnar nerve had been divided a short distance above the wrist-joint, the first phalanges of the ring and little fingers were bent (extended) upon their articulating metacarpal bones, the second and third phalanges being flexed at obtuse angles upon their proximal phalanges; the index and middle fingers being normal. I attribute this condition to paralysis of the two ulnar lumbricales and not to loss of power of the interossei. I have seen about a dozen instances of division of the ulnar nerve, and in all of them the same condition of the little and ring fingers has existed.

[The common action of the interossei is to flex the first and extend the second and third phalanges. — A. H.]

The *posterior sterno-clavicular ligament*, stronger and denser than the anterior, extends over the back of the joint, its fibres passing downwards and inwards from the back of the clavicle to the back of the sternum in a similar manner of the anterior.

The *interclavicular ligament* connects the clavicles directly. It extends transversely along the notch of the sternum, and has a broad attachment to the upper border of each clavicle. Between the clavicles it is more or less attached to the sternum, so that it forms a curve with the concavity upwards.

The three ligaments just described are so closely connected that, collectively, they form for the joint a complete fibrous capsule of such strength that dislocation of it is rare.

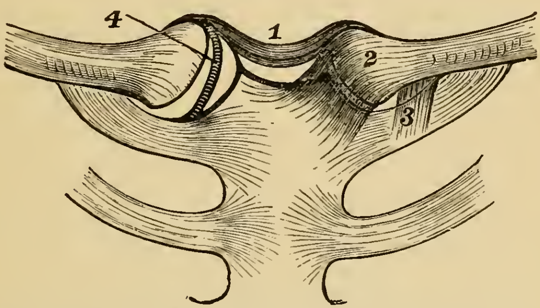


FIG 150. — DIAGRAM OF THE STERNO-CLAVICULAR LIGAMENTS.

1. Interclavicular ligament. 2. Anterior sterno-clavicular ligament. 3. Costo-clavicular ligament 4. Interarticular fibro-cartilage

The *costo-clavicular* or *rhomboid ligament* connects the clavicle to the cartilage of the first rib. It ascends obliquely outwards and backwards from the cartilage of the rib to a rough surface beneath the sternal end of the clavicle. Its use is to limit the elevation of the clavicle. There is such constant movement between the clavicle and the cartilage of the first rib that a well-marked *bursa* is commonly found between them.

Interarticular fibro-cartilage. To see this, cut through the rhomboid, the anterior and posterior ligaments of the joint, and raise the clavicle. It is nearly circular in form, and thicker at the circumference than the centre, in which there is sometimes a perforation, and divides the articulation into two cavities. Inferiorly, it is attached to the cartilage of the first rib, close to the sternum; superiorly, to the upper part of the clavicle and the

interclavicular ligament. Its circumference is inseparably connected with the anterior and posterior ligaments.*

The joint is provided with *two synovial membranes:* one between the articular surface of the sternum and the inner surface of the fibro-cartilage; the other between the articular surface of the clavicle and the outer surface of the fibro-cartilage.

This interarticular fibro-cartilage is a structure highly elastic, without admitting of any stretching. It equalizes pressure, breaks shocks, and also acts as a ligament, tending to prevent the clavicle from being driven inwards towards the mesial line.

Observe the relative form of the cartilaginous surfaces of the bones: that of the sternum is slightly concave in the transverse, and convex in the antero-posterior direction; that of the clavicle is the reverse.

The form of the articular surfaces and the ligaments of a joint being known, it is easy to understand the movements of which it is capable. The clavicle can be moved upon the sternum in a direction either upwards, downwards, backwards, or forwards; it also admits of circumduction. These movements, though limited at the sternum, are considerable at the apex of the shoulder.†

Scalpo-clavicular Joint.—The outer end of the clavicle articulates with the acromion, and is connected by strong ligaments to the coracoid process of the scapula.

The clavicle and the acromion articulate with each other by two flat oval cartilaginous surfaces, of which the planes slant inwards, and the longer diameters are in the antero-posterior direction. It is an arthrodial joint.

The *superior acromio-clavicular ligament*, a broad band of

* Interarticular fibro-cartilages (menisci) also exist in the following joints: acromio-clavicular, temporo-mandibular, knee, and wrist joints. Professor Humphry has shown that interarticular cartilages augment the variety of movements in a joint, permitting for instance that of rotation in the knee-joint, in addition to that of extension and flexion, which otherwise would be the only possible ones.

† Professor Humphry, in describing the movements of this joint, in his valuable work, "On the Human Skeleton," says, "The movements attendant on elevation and depression of the shoulder take place between the clavicle and the interarticular ligament, the bone rotating upon the ligament on an axis drawn from before backwards through its own articular facet. When the shoulder is moved forwards and backwards, the clavicle, with the interarticular ligament, rolls to and fro on the articular surface of the sternum, revolving, with a slightly sliding movement, round an axis drawn nearly vertically through the sternum. In the circumduction of the shoulder, which is compounded of these two movements, the clavicle revolves upon the interarticular cartilage, and the latter, with the clavicle, rolls upon the sternum."

parallel ligamentous fibres, strengthened by the aponeurosis of the trapezius, extends from the upper surface of the acromion to the upper surface of the clavicle.

The *inferior acromio-clavicular ligament*, of less strength, extends along the under surface of the joint from bone to bone.*

An *inter articular fibro-cartilage* is sometimes found in this joint; but it is incomplete, and seldom extends lower than the upper half. There is only one synovial membrane.

Coraco-clavicular ligament. The clavicle is connected to the coracoid process of the scapula by two strong ligaments † — the *conoid* and *trapezoid* — which, being continuous with each other, should be considered as one. The *trapezoid* ligament is the more anterior and external. Quadrilateral in shape, it arises from the back of the upper surface of the coracoid process, and ascends obliquely backwards and outwards to the oblique line on the under aspect of the clavicle, near its outer end. The *conoid* ligament, triangular in form, is situated behind the trapezoid ligament to the posterior border of which it is attached. It is fixed at its apex to the root of the coracoid process, ascends nearly vertically, and is attached by its base to the clavicle. The coraco-clavicular ligaments fix the scapula to the clavicle, and prevent undue rotation of the scapula. When the clavicle is fractured in the line of the attachment of the coraco-clavicular ligament, there is little or no displacement of the fractured ends, these being kept in place by the ligament.

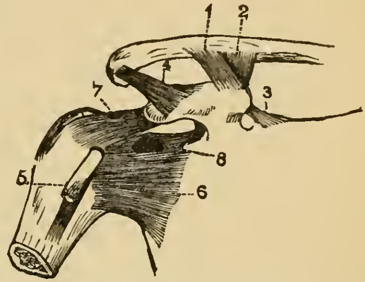


FIG. 151. — ANTERIOR VIEW OF THE SCAPULO-CLAVICULAR LIGAMENTS, AND OF THE SHOULDER-JOINT.

1. Trapezoid portions of the coraco-clavicular ligament. 2. Conoid portions of the coraco-clavicular ligament. 3. Suprascapular or transverse ligament. 4. Coraco-acromial ligament. 5. Tendon of biceps. 6. Capsular ligament of the shoulder-joint. 7. Coraco-humeral ligament. 8. Foramen in the capsular ligament for the subscapularis tendon.

Ligaments of the Scapula. — These are three: the *coraco-acromial* or *triangular* ligament, attached by its apex to the tip

* The superior and inferior ligaments practically make a capsular ligament, and are described as such by some authors.

† This is a union and not a joint proper, as it is but rarely that the bones are found in contact, and when this does take place articular cartilage covers their union, and a synovial membrane is present. — A. H.

of the acromion process, and by its base to the outer border of the coracoid process; it is separated from the upper part of the capsule of the shoulder-joint by a large bursa; and the *transverse* or *coracoid* ligament, which passes across the suprascapular notch, converting it into a foramen. The *inferior transverse* or *spino-glenoid* ligament is attached to the external margin of the spine of the scapula immediately above the glenoid cavity, and extends in an oblique direction to the upper and posterior margin of the glenoid cavity. It makes a foramen for the suprascapular vessels and nerve to gain the infraspinous fossa, and protects these structures from pressure. — A. H. The suprascapular vessels pass over the foramen, the suprascapular nerve through it.

Shoulder-joint. — The articular surface of the head of the humerus, forming rather more than one-third of a sphere, moves upon the shallow glenoid cavity of the scapula, which is of an almond shape, with the broader end downwards and the long diameter nearly vertical. The security of the joint depends not upon any mechanical contrivance of the bones, but upon the great strength and number of the ligaments and tendons which surround and are intimately connected with it. It is an enarthrodial, or ball-and-socket joint.

To admit the free motion of the head of the humerus upon the glenoid cavity it is requisite that the *capsular ligament* of the joint be loose and capacious. Accordingly, the head of the bone, when detached from its muscular connections, may be separated from the glenoid cavity to the extent of an inch (*2.5 cm.*) or more, without laceration of the capsule. This explains the elongation of the arm observed in some cases in which effusion takes place into the joint; also in cases of paralysis of the deltoid.

The *capsular ligament* is attached above, round the circumference of the glenoid cavity; below, round the anatomical neck of the humerus. It is strongest on its upper aspect, weakest and longest on its lower. It is strengthened on its upper and posterior part by the tendons of the supraspinatus, infraspinatus, and teres minor;* its inner part is strengthened by the broad tendon of the subscapularis and the coraco-humeral ligament; its lower part by the long head of the triceps.

* Occasionally these tendons enter the capsule as the tendon of the biceps muscle forming processes from the subacromial bursa. — A. H.

Thus the circumference of the capsule is surrounded by tendons on every side, excepting a small space towards the axilla. If the humerus be raised, it will be found that the head of the bone rests upon this unprotected portion of the capsule, between the tendons of the subscapularis and the long head of the triceps ; through this part of the capsule the head of the bone is first protruded in dislocations into the axilla.

At the upper and inner side of the joint, a small opening is observable in the capsular ligament, through which the tendon of the subscapularis passes, so that the synovial membrane of the joint communicates with the bursa under the tendon of this muscle. A second opening exists in the lower part of the front of the capsular ligament, where the tendon of the biceps emerges from the joint. A third opening occasionally exists between the joint and a bursa under the tendon of the infraspinatus muscle.

The upper and inner surface of the capsule is strengthened by a strong band of ligamentous fibres, called the *coraco-humeral* or *accessory ligament.* It is attached to the root of the coracoid process, and extending to the tip, expands over the upper surface of the capsule, with which it is inseparably united, and, passing downwards and outwards, is attached to the greater tuberosity of the humerus.

Open the capsule to see the *tendon* of the *long head of the biceps.* It arises by a rounded tendon from the upper margin of the glenoid cavity, and is continuous with the glenoid ligament ; becoming slightly flattened, it passes over the head of the humerus, descends through the groove between the two tuberosities, and, after piercing the capsular ligament of the shoulder-joint, it passes along the bicipital groove, being retained in situ by an aponeurotic prolongation from the tendon of the pectoralis major. It is loose and movable within the joint. It acts like a strap, keeping down the head of the bone when the arm is raised by the deltoid, and then might be considered as taking the part of a ligament of the joint.

The tendon of the biceps, strictly speaking, does not perforate the synovial membrane of the joint. It is enclosed in a tubular sheath, which is reflected over it at its attachment to the glenoid cavity, and accompanies it for two inches (*5 cm.*) down the groove of the humerus.

The *gleno-humeral* ligament is attached to the base of the coracoid process, is internal to the capsule and the margin of

the glenoid cavity, and runs to the lesser tuberosity of the humerus. It is attached to the capsule and meets the tendon of the biceps at an acute angle.* There are two other processes, less marked; one connecting the glenoid cavity and lesser tuberosity, derived from the subscapularis tendon; the other from the inferior part of the glenoid cavity to the inferior part of neck of the humerus. This ligament is best seen in the fœtal state.

The margin of the glenoid cavity of the scapula is surrounded by a fibro-cartilaginous band of considerable thickness, called the *glenoid ligament.* This not only enlarges, but deepens the cavity. Superiorly, it is continuous on either side with the tendon of the biceps; inferiorly, with the tendon of the triceps; in the rest of its circumference it is attached to the edge of the cavity.

The cartilage covering the head of the humerus is thicker at the centre than at the circumference. The reverse is the case in the glenoid cavity.

The *synovial membrane* lining the under surface of the capsule is reflected around the tendon of the biceps, and passes with it in the form of a cul-de-sac down the bicipital groove. On the inner side of the joint it always communicates with the bursa beneath the tendon of the subscapularis.

There is also a large bursa situated between the capsule and the deltoid muscle, which does not communicate with the joint.

The muscles in relation with the joint are: above, the supraspinatus; behind, the infraspinatus and teres minor; below, the long head of the triceps; internally, the subscapularis; and, inside the joint, the long head of the biceps.

The shoulder-joint is an enarthrodial joint, and has a more extensive range of motion than any other joint in the body; it is what mechanics call a universal joint. It is capable of motion forwards and backwards, of adduction, abduction, circumduction, and rotation. The various movements are limited chiefly by the surrounding muscles and by atmospheric pressure, for the capsule is so lax as to offer no obstacle to the freedom of movement in any direction. The amount of rotation which the head of the humerus is capable of, is to the extent of a quarter of a circle.

The movements of which the shoulder-joint is capable are effected by the following muscles, thus:—

* Morris's Anatomy, 1898.

Extension is effected by the posterior fibres of the deltoid, latissimus dorsi, teres major, and (when the arm is raised) by the infraspinatus and teres minor.

Flexion, by the anterior fibres of the deltoid, coraco-brachialis, and the pectoralis major (slightly).

Abduction, by the deltoid and the supraspinatus.

Adduction, by the pectoralis major, latissimus dorsi, teres major, coraco-brachialis, and (when the arm is raised) by the subscapularis.

Rotation inwards, by the subscapularis, latissimus dorsi, and teres major.

Rotation outwards, by the infraspinatus and the teres minor.*

Elbow-joint. — The elbow-joint is a ginglymus or hinge-joint. The larger sigmoid cavity of the ulna is adapted to the trochlea upon the lower end of the humerus, admitting only of flexion and extension; while the shallow excavation upon the head of the radius admits not only of free flexion and extension, but of central rotation, upon the rounded articular eminence (*capitellum*) of the humerus, and of peripheral rotation at the superior radio-ulnar articulation.

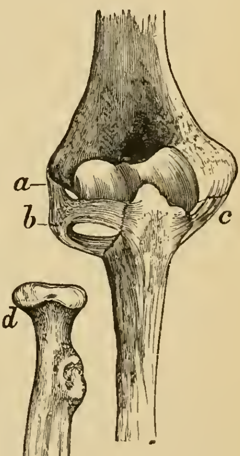


Fig. 152. — Ligaments of the Elbow-Joint.

a. External lateral ligament. *b*. Orbicular or annular ligament. *c*. Part of internal lateral ligament. *d*. Radius, removed from the annular ligament.

The joint is secured in front and behind by *anterior* and *posterior* ligaments, and laterally by *two* strong *lateral* ligaments. No ligament is attached to the head of the radius, otherwise its rotary movement would be impeded. The head is simply surrounded by a ligamentous collar, called the annular ligament, within which it freely rolls in pronation and supination of the hand.

The *anterior ligament* consists of broad, thin inverted V-shaped ligamentous fibres, attached above to the front of the humerus, above the coronoid fossa, below to the coronoid process of the ulna and to the orbicular ligament, and continuous on each side with the lateral ligaments.

* With the humerus vertical the supraspinatus will act as an external rotator. It should also be borne in mind that the joint depends more for its strength upon the muscles and their tendons which surround it than upon the ligaments. — A.H.

The *posterior ligament* is composed of thin, loose, inverted V-shaped fibres attached above to the margin of the olecranon fossa, below to the border of the olecranon, and spread over the posterior aspect of the joint.

The *internal lateral ligament* is thick, tense, strong and triangular, and is divided into two portions, an anterior and a posterior. Its *anterior part* is attached to the front of the internal condyle of the humerus; from this point the fibres radiate, and are inserted along the inner margin of the coronoid process of the ulna. The *posterior part* is also triangular, and passes from the back part of the internal condyle to the inner border of the olecranon.

A band of fibres extends transversely from the olecranon to the coronoid process, across a notch observable on the inner side of the sigmoid cavity; through this notch small vessels pass into the joint.

The *external lateral ligament*, thick, tense and strong, is attached to the external condyle of the humerus, and is in intimate connection with the common tendon of the extensors. The fibres spread out as they descend, and are interwoven with the annular ligament surrounding the head of the radius.

The preceding ligaments, collectively, form a continuous capsule for the joint.

It must be remembered that the strength of the joint depends upon its bony formation.

Superior Radio-ulnar Articulation. — The *orbicular* or *annular ligament of the radius* forms about three-fourths of a ring. Its ends are attached to the anterior and posterior borders of the lesser sigmoid cavity of the ulna, and is broader in the middle than at either end. Its lower border is straight; its upper border is convex, and connected with the anterior and external lateral ligaments. With this sigmoid cavity it forms a complete collar, which encircles the head, and part of the neck, of the radius. The lower part of the ring is narrower than the upper, the better to clasp the neck of the radius, and maintain it more accurately in position.

Synovial membrane of the elbow-joint. Open the joint by a transverse incision in front, and observe the relative adaptation of the cartilaginous surfaces of the bones. The synovial membrane lines the interior of the capsule, and forms a cul-de-sac between the head of the radius and its annular ligament. It is widest and loosest under the tendon of the triceps. Where the

membrane is reflected from the bones upon the ligaments, there is more or less adipose tissue, particularly in the fossæ on the front and back part of the lower end of the humerus.

The only movements permitted between the humerus and the ulna are those of flexion and extension, both of which are limited by the ligaments and tendons in front of and behind the joint, and probably not by the coronoid and olecranon processes. The head of the radius is most in contact with the capitellum of the humerus during semiflexion and semipronation ; and it is kept, by the strong orbicular ligament which surrounds the neck of the radius, from being dislocated forwards by the biceps. The movement at the superior radio-ulnar articulation is that of rotation in the lesser sigmoid cavity of the ulna, forming an example of a lateral ginglymus or diarthrosis rotatoria. It is by this rotation of the head of the radius that the hand is carried through an extensive range of pronation and supination ; for it is articulated only to the lower end of the radius, the ulna being excluded by the interarticular fibro-cartilage from taking any share in the movement at the wrist-joint.

Interosseous Membrane or Mid Radio-ulnar Union. — This is an aponeurotic septum, stretched between the interosseous ridges of the radius and ulna, of which the chief purpose is to afford an increase of surface for the attachment of muscles. The septum is deficient above, beginning about an inch (*2.5 cm.*) below the tubercle of the radius, and thus permits free rotation of that bone. Its fibres extend obliquely downwards from the radius to the ulna. It is perforated in its lower third by the anterior interosseous vessels.

The name of *round* or *oblique ligament* is given to a thin band of fibres, which extends obliquely between the bones of the forearm in a direction contrary to those of the interosseous membrane. It is attached, superiorly, to the front surface of the ulna, near the outer side of the coronoid process ; inferiorly, to the radius immediately below the tubercle. Between this ligament and the upper border of the interosseous membrane is a triangular interval through which the posterior interosseous artery passes to the back of the forearm. A *bursa* intervenes between the oblique ligament and the insertion of the tendon of the biceps. The use of this ligament is to limit supination of the radius.

Inferior Radio-ulnar Articulation. — This joint is a lateral ginglymus, and is formed by the inner concave surface of the lower end of the radius rotating upon the convex head of the

ulna; which mechanism is essential to the pronation and supination of the hand. These corresponding surfaces are encrusted with a thin layer of cartilage, and are provided with a very loose synovial membrane. The surfaces are maintained in position by an anterior and a posterior radio-ulnar ligament, and a triangular fibro-cartilage.

The *anterior radio-ulnar ligament* is a thin fasciculus extending obliquely inwards from the anterior border of the sigmoid cavity of the radius to the head of the ulna.

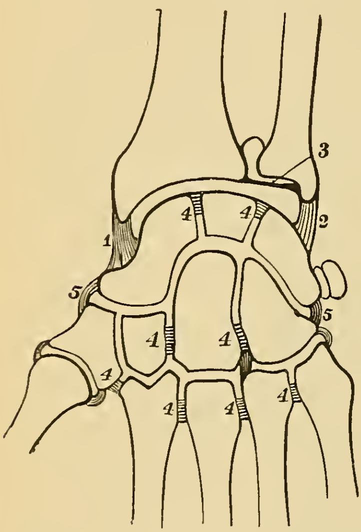


Fig. 153. — Diagram of the Ligaments and Synovial Membranes of the Wrist-joint.

1. External lateral ligament. 2. Internal lateral ligament. 3. Interarticular fibro-cartilage between radius and ulna. 4. Interosseous ligaments. 5. Lateral ligaments of the intercarpal joint.

The *posterior radio-ulnar ligament* passes from the posterior border of the sigmoid cavity to the posterior surface of the styloid process of the ulna.

The *triangular fibro-cartilage* between the radius and ulna is the principal uniting medium between the bones. To see it, saw through the bones of the forearm, and separate them by cutting through the interosseous membrane, and opening the synovial membrane of the joint between the lower ends. Thus a good view is obtained of the fibro-cartilage which connects them (Fig. 153). It is triangular, and placed transversely at the lower end of the ulna, filling up the interval caused by the greater length of the radius. Its base is attached to the lower end of the radius; its apex to a depression at the root of the styloid process of the ulna. It is thin at the base and centre, thicker at the apex and sides. Its upper surface is in contact with the ulna, and covered by the synovial membrane of the inferior radio-ulnar joint; its lower surface, forming a part of the wrist-joint, is contiguous with the cuneiform bone. Its borders are connected with the anterior and posterior ligaments of the wrist. In some instances there is an aperture in the centre. When, from accident or disease, this fibro-cartilage gets detached from the radius, the conse-

quence is an abnormal projection of the lower end of the ulna.

The *synovial membrane* of this joint is distinct from that of the wrist, except in the case of a perforation through the fibro-cartilage. On account of its great looseness, necessary for the free rotation of the radius, it is called *membrana sacciformis.*

The movement between the lower ends of the radius and ulna is due to the rotation of the radius round the articular head of the ulna, and is confined to rotation forwards or *pronation,* and to rotation backwards or *supination;* the extent of movement being limited by the anterior and posterior ligaments.

The area described by this joint in pronation and supination is one hundred and thirty-five degrees; it must not be forgotten, however, that this is increased by the rotation at the shoulder joint. — A. H.

Radio-carpal or Wrist-joint. — This is an arthrodial joint of condyloid variety, and is formed: above, by the lower end of the radius and the distal surface of the triangular fibro-cartilage as the receiving cavity; below, by the scaphoid, semilunar and cuneiform bones as the condyle, the two former articulate with the two facets on the radius, the latter with the fibro-cartilage. The joint is secured by an anterior, a posterior and two lateral ligaments.

The *external lateral ligament* extends from the tip of the styloid process of the radius to the outer side of the scaphoid bone, to the anterior annular ligament, and to the trapezium.

The *internal lateral ligament* is round, and proceeds from the extremity of the styloid process of the ulna to the cuneiform bone. Another fasciculus is attached to the pisiform bone and the anterior annular ligament.

The *anterior ligament* consists of two or more broad bands of ligamentous fibres, which extend from the lower end of the radius to the first row of carpal bones, except the pisiform.

The *posterior ligament,* weaker than the preceding, proceeds from the posterior surface of the lower end of the radius, and is attached to the posterior surfaces of the first row of carpal bones.

The *synovial membrane* lines the under surface of the triangular fibro-cartilage at the end of the ulna, is reflected over the several ligaments of the joint, and thence upon the first row of the carpal bones (Fig. 153).

This articulation allows of all the movements of enarthrodial

joints, except that of rotation: thus, it allows of flexion, extension, abduction, adduction, and circumduction, so that it is, strictly speaking, only an arthrodial joint.

Carpal Joints. — The bones of the carpus are arranged in two rows, an upper and a lower, adapted to each other so as to form between them a joint. The articulations may be best arranged in three sets: those between the carpal bones of the first row; between those of the second row; and the articulation of the two rows with each other: they are all examples of arthrodial joints.

a. The *first row of carpal bones* are connected together by two palmar, two dorsal, and two interosseous ligaments.

The *dorsal* and *palmar transverse ligaments* proceed, on the dorsal and palmar aspects, from the scaphoid to the semilunar bone, and from the semilunar to the cuneiform bone: the dorsal being the stronger; the *interosseous* ligaments connect the semilunar with the bones on each side of it (Fig. 153).

The *pisiform bone* is articulated to the palmar surface of the cuneiform bone, to which it is united by a fibrous capsule. Inferiorly, it is attached by two strong ligaments, the one to the unciform bone, the other to the carpal end of the fifth metacarpal bone. This articulation has a distinct synovial membrane.

b. The *second row of carpal bones* is connected by three dorsal, three palmar, and two interosseous ligaments.

The *dorsal* and *palmar ligaments* pass transversely from one to the other. There are usually *two interosseous ligaments*, one on either side of the os magnum; sometimes there is a third, between the trapezium and trapezoid bones; they are thicker and stronger than those of the upper row, and unite the bones more firmly together.

c. The first row of carpal bones is arranged in the form of an arch, as a receiving cavity, so as to receive the corresponding surfaces of the os magnum and unciforme, as a condyle. External to the os magnum, the trapezium and trapezoid bones present a slightly concave surface, which articulates with the scaphoid. In this way a joint, admitting of flexion and extension only, is formed between the upper and lower row.

The *two rows of carpal bones* are connected together by palmar and dorsal ligaments, and by an external and an internal lateral ligament.

The *palmar ligaments* consist of strong ligamentous fibres,

which pass obliquely from the bones of the first to those of the second row.

The *dorsal ligaments* consist of oblique and transverse fibres which connect the dorsal surfaces of the bones of the upper with the lower row.

The *external lateral ligament*, very distinct, passes from the scaphoid to the trapezium: the *internal lateral ligament* from the cuneiform to the unciform.

Divide the ligaments to see the manner in which the carpal bones articulate with one another. Their surfaces are crusted with cartilage, and have a *common synovial membrane* which is very extensive and lines the distal surfaces of the scaphoid, semilunar, and cuneiform bones; it then passes forwards between the trapezium and trapezoid, the trapezoid and os magnum, the os magnum and the cuneiform to the articulations between the second row of carpal bones and the metacarpal bones of the four fingers (Fig. 153).

Joints between Trapezium and the First Metacarpal Bone. — The trapezium presents a cartilaginous surface, convex in the transverse, and concave in the antero-posterior direction (*i.e.*, saddle-shaped), which articulates with the cartilaginous surface on the metacarpal bone of the thumb, concave and convex in the opposite directions. This peculiar adaptation of the two surfaces permits the several movements of the thumb — viz., flexion, extension, abduction, and adduction; consequently circumduction. It is an arthrodial joint, but permits of such extensive movement, that it is described by some anatomists as one by "reciprocal reception." Thus we are enabled to oppose the thumb to all the fingers, which is one of the great characteristics of the human hand. The joint is surrounded by a *capsular ligament* sufficiently loose to admit free motion, and stronger on the dorsal than on the palmar aspect. The security of the joint is increased by the muscles which surround it. It has a *separate synovial membrane*.

Carpo-metacarpal Joints. — The metacarpal bones of the fingers are connected to the second row of the carpal bones by ligaments upon their *palmar* and *dorsal* surfaces, and by interosseous ligaments.

The *dorsal* ligaments are the stronger. The metacarpal bone of the forefinger has two: one from the trapezium, the other from the trapezoid bone. That of the middle finger has also two, proceeding from the os magnum and the os trape-

zoides. That of the ring finger has also two, proceeding from the os magnum and the unciform bone. That of the little finger has one only, from the unciform bone.

The *palmar* ligaments are arranged nearly upon a similar plan. The metacarpal bone of the forefinger has one from the trapezoid bone. That of the middle finger has three, proceeding from the trapezium, the os magnum, and the unciform bone. Those of the ring and little fingers have each one, from the unciform bone.

Besides the preceding ligaments, there are some of considerable strength, called the *interosseous*. They proceed from the adjacent sides of the os magnum and the os unciforme, descend vertically, and are fixed into the radial side of the metacarpal bone of the middle and ring fingers (Fig. 153). This ligament occasionally isolates the synovial membrane of the two inner metacarpal bones from the common synovial membrane of the carpus.

Separate the metacarpal bones from the carpus, and observe the relative form of their contiguous surfaces. The metacarpal bones of the fore and middle fingers are adapted to the carpus in such an angular manner as to be almost immovable. The metacarpal bone of the ring finger, having a plane articular surface with the unciform bone, admits of more motion. Still greater motion is permitted between the unciform and the metacarpal bone of the little finger, the articular surface of each being slightly concave and convex in opposite directions. The greater freedom of motion of the metacarpal bone of the little finger is essential to the expansion and contraction of the palm.

The *carpal extremities of the metacarpal bones of the fingers* are connected with each other by *palmar* and *dorsal transverse ligaments*. They are also connected by *interosseous* ligaments, which extend between the bones, immediately below their contiguous cartilaginous surfaces.

The *distal extremities* of these bones are loosely connected on their palmar aspect by the *transverse metacarpal* ligament.

Synovial Membranes of the Wrist.—There are five, sometimes six, distinct synovial membranes, proper to the lower end of the radius, and the several bones of the carpus (Fig. 153, p. 410), as follows:—

a. One between the lower end of the radius and the ulna.

b. One between the radius and the first row of carpal bones.

c. One between the trapezium and the metacarpal bone of the thumb.

d. One between the cuneiform and pisiform bones.

e. One between the first and second rows of carpal bones (the intercarpal joint). This extends to the metacarpal bones of the four inner fingers.

The interosseous ligament between the os magnum and ring finger occasionally shuts off the synovial membrane between the unciform and two inner metacarpal bones from the large intercarpal sac; thus making the sixth distinct synovial membrane.

First Joint of the Fingers. — The first phalanx of the finger presents a shallow oval receiving cavity, crusted with cartilage, with the broad diameter in the transverse direction, to articulate with the round condyloid cartilaginous head of the metacarpal bone, of which the articular surface is elongated in the antero-posterior direction, and of greater extent on its palmar than its dorsal aspect. This formation of parts permits flexion of the finger to a greater degree than extension; and also a slight lateral movement.

Each joint is provided with two strong *lateral* ligaments, and an anterior or *palmar* ligament.

The *lateral ligaments* arise from the tubercles on either side of each metacarpal bone, and, inclining slightly forward, are inserted into the sides of the base of the first phalanx of the finger.

The *anterior* (*glenoid*) *ligament* is a thick, compact, fibrous structure, which extends over the palmar surface of the joint between the lateral ligaments. Its distal end is firmly attached to the base of the first phalanx of the finger; its proximal end is loosely adherent to the rough surface above the head of the metacarpal bone. On either side it is inseparably connected with the lateral ligaments, so that with them it forms a strong capsule over the front and sides of the joint. Its superficial surface, firmly connected with the transverse ligament, is slightly grooved for the play of the flexor tendons; its deep surface is adapted to cover the head of the metacarpal bone. Two sesamoid bones are found in the palmar ligament belonging to the joint between the metacarpal bone and the first phalanx of the thumb.

The palmar ligaments have a surgical importance for the following reason: In dislocation of the fingers, the facility of reduction mainly depends upon the extent to which the glenoid ligament is injured. If it be much torn, there is but little difficulty: if entire, the reduction may require much manipulation.

These joints are secured on their dorsal aspect by the extensor tendon, and the expansion proceeding from it on either side. Their synovial membranes are loose, especially beneath the extensor tendons.

Second and Last Joint of the Fingers. — The corresponding articular surfaces of the phalanges of the fingers and thumb are so shaped as to form a hinge-joint (*ginglymus*), and, therefore, incapable of lateral movement. The ligaments connecting them are similar in every respect to those between the metacarpal bones and the first phalanges. The palmar ligament of the last joint of the thumb generally contains a sesamoid bone.

The wrist-joint is a complex articulation, in which the seat of movement is partly in the radio-carpal, and partly in the intercarpal articulation. Thus the hand at the radio-carpal joint is capable of extension (dorsi-flexion) and flexion, the latter being the most free; it is also capable of adduction (ulnar flexion) and of abduction (radial flexion) to a lesser extent. Between the carpal bones and carpo-metacarpal bones, the movement which takes place when the hand is pressed down so as to support the weight of the body, is that of separation of the anterior part of their apposed surfaces; undue separation being prevented by the interosseous and palmar ligaments. The articulation between the unciform and fourth and fifth metacarpals is not so firm as that between the other carpo-metacarpal bones, consequently there is greater freedom of motion forwards, seen in deepening the palm and in shutting the hand. The movements at the metacarpo-phalangeal articulation are those of extension and flexion, of adduction and abduction, the two latter being most marked in extension of the finger. Between the thumb and trapezium all the movements of an enarthrodial joint exist, except that of rotation; a little rotation probably takes place when the metacarpal bone is flexed. In the interphalangeal and phalangeal joints, the only movements permitted are those of extension and flexion.

INDEX

D.

H.

I.

M.

N.

O.

P.

R.

S.

T.

W.

Z.